MEDICAL SCIENCES

A

SYSTEM

OF

COMPARATIVE ANATOMY

AND

PHYSIOLOGY.

VOL. I.

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CAMBRIDGE,

PRINTED BY J. BURGES PRINTER TO THE UNIVERSITY;

AND SOLD BY W. H. LUNN, AND J. DEIGHTON CAMBRIDGE; MESSRS. WHITE, FLEET-STREET, AND J. WALTER, CHARING-CROSS, LONDON; AND J. COOK, OXFORD.

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A

SYSTEM

OF

COMPARATIVE ANATOMY, &c.

CHAP. I.

ON THE BRAIN, AND ORGANS OF SENSE.

SECT. I.

INTRODUCTION.

THE mode of connection between Soul and Body, and the agency of Matter on Spirit in the production of Thought, are involved in impenetrable obscurity. Curiosity is eager to discover by what mechanism, distinct, and even opposite natures, can be united in the same creature; whilst a principle far more laudable, the desire of useful information, impels us to pursue the enquiry. If in matters of inferior importance, these motives be almost irresistible, can we wonder that men of distinguished ability, in every age, have devoted so much time and thought to the investigation of the Brain; that wonderful and anomalous organ, placed on the doubtful confines of the material and spiritual worlds?

The skill of the Anatomist has demonstrated every process, explored every cavity, and would, if possible, have traced every filament, of this inexplicable mass; nor have the Physiologist and Metaphysician been less eager to discover, and assign to each part it's peculiar office. Whatever may be due to the former for accuracy, and to the latter for ingenuity and zeal, we must lament that little real knowledge has resulted from their labours*. At this advanced period of science, when almost every other subject has been illuminated by the experiments, the deductions, and even by the conjectures of the learned, we are not able to proceed a single step beyond the fathers of medicine; who in the very infancy of our art, pronounced this inscrutable mass of organized matter, to be the fountain † and the reservoir, the beginning and the end of the whole nervous system, where every idea originates, and to which every sensation is referred.

The Brain may be considered in a twofold capacity; as the receptacle of sensation, and the instrument of thought. Although there can be no doubt, that the nerves which connect it with every part of the body are the means by which it's sensations are produced; yet with respect to the operative cause of their agency, we have very few and imperfect, if indeed we can be said to have any, ideas ‡; it is a task still more arduous and hopeless to discover,

* The advantages, which Pathology and Therapeutics have derived from this source, are not here the subject of discussion.

† Ἅπαντ' ἔν ἐγκεφάλῳ κεκοινώνηκεν, εἰ χρὴ πιστεύειν ὀφθαλμοῖς ὁρωσι, καὶ χερσὶν ἁπτομέναις.

Omnia namque cerebro participant, si oportet credere oculis videntibus et manibus tangentibus. Galen de usu partium, Lib. viii.

Ἀποδέδεικται δὲ, ἐν τοῖς περὶ τῶν Ἱπποκράτους καὶ Πλάτωνος δογμάτων, ἀρχὴν μὲν νεύρων, καὶ συμπάσης αἰσθήσεώς, τε, καὶ τῆς κατὰ προαίρεσιν κινήσεως τὸν ἐγκέφαλον ὑπάρχειν.

Demonstratum est in libro de dogmatibus Hippocratis et Platonis, principium nervorum et universi sensus, et motus voluntarii esse cerebrum. Idem.

‡ A gleam of light in the midst of this darkness seemed to break upon us from the experiments of Galvani and Valli on animal electricity: but notwithstanding the ingenious

discover, how these various sensations are modified into the numerous operations, which constitute the different faculties of the mind.

When we dissect the Brain, and observe the different substances of which it is composed, and their different forms, Imagination, assuming the office of Reason, would willingly assign a peculiar use to every part; and pronounce one to be the residence, or rather the instrument of memory, another of abstraction, a third of volition, &c. When a sensation is excited by the action of any substance upon the body, we immediately perceive upon what part of the body the substance acts—where the impression begins—and, as the impression is conveyed by the nerves to the brain, it is conceivable, that we might have been so constituted, as to perceive with the same facility, in what part of the brain the impression ends. This, however, experience convinces us, we are not able to determine.

Abandoning the vain attempt, we flatter ourselves, that some resource is left to us in comparative anatomy; and indeed at first view it seems not at all improbable, that in different animals there should be some marked peculiarities in the structure of the brain, corresponding with their different habits and sagacities. Whatever our hopes or wishes may be; from this source little if any thing has hitherto been derived; nor have I advanced a single step beyond my predecessors.

If unable to explain the operations of intellect, we consider the brain solely as the receptacle of sensation, much of that obscurity, which before darkened and impeded our progress, is dispelled. Though we do not comprehend the mode by which a sensation is communicated,

nious remarks and illustrations of Professor Monro and others, we seem to have advanced no farther than to make it probable that the nervous fluid, or energy, is considerably influenced by electricity, or something like it. With respect to the nervous energy itself, we are still in the dark.

communicated, yet the instruments of communication are clearly perceptible by our senses. The nerves having taken their departure from the brain, are distributed on the various organs, where their operations commence, and where alone their sensibility appears to reside. We can trace them from the Sensorium itself, to the seat of sense; we can compare their various magnitudes, and distributions in different animals; we can illustrate the obscurity of one subject, by the reflected light of another; and by extending the boundaries of knowledge, exalt the mind to the most congenial of all it's operations, the adoration of the Almighty Creator.

By these considerations I have been induced to speak very concisely of the Brain itself; and then to proceed to a more particular examination of the several *senses;* adopting that order in their arrangement, which general custom, though without any apparent reason, has prescribed.

In comparing the organs of *sense* in the different tribes, we shall find them varying in subtilty, according to the habits and exigencies of the animals, to which they are respectively subservient. If the attainment of sustenance depends chiefly on the scent, the nose is endowed with extraordinary powers for the perception of distant or hidden food; if on the sight, the eye is furnished with a peculiar apparatus, by which, in some animals, vision is rendered more perfect by day, in others by night.

The Ear, although to most animals, not of equal importance with the nose, or the eye, has still enough to command our admiration, and affords an extensive field for observation, and experiment.

The comparative anatomy of this organ has lately engaged the attention of our most eminent Physiologists, whose discoveries have

have led to a more intimate acquaintance with it's structure. The valuable accessions which Hunter, Camper, and Monro have brought to the common stock of knowledge, should be received with gratitude, and improved with care.

The sense of Taste will admit of but little investigation; it is nevertheless a more active sense in man, than in other animals; and in him, is capable of exciting a greater degree both of disgust, and pleasure, than the neighbouring and allied sense of Smelling; to which in the brute creation, it seems altogether subservient.

The sense of Feeling is preeminently fine in some parts of the human body; this refined state of it has very properly been distinguished by the name of Touch. A certain portion of feeling is necessarily coexistent with the vital principle; and without this essential property, we can scarcely conceive, that there can be such a thing as animal existence.

From what I have here advanced, the reader will naturally expect in the first Chapter of this work, a short account of the Brain and its functions; a more elaborate discussion of the organs of sense connected with it; a general description of their structure; and lastly, such remarks and observations as are the result of physiological reasoning upon their comparative anatomy, and the peculiar advantages, which evidently arise from their variety in the different classes of animals.

SECT. II.

OF THE BRAIN, AND ORGANS OF SENSE.

THE very term *Animal* seems to imply, that there are certain obvious and general analogies, in the structure of that class of Beings which is comprehended under it: the properties common to all are indeed but few; and among these the endowment of brain is not to be included. The Earthworm, Leach and Polypus, and many of those which are denominated imperfect animals, have no brain; their animality consists merely in the possession of locomotive powers, and of the sense of feeling in no very high degree of perfection: but *Man*, of all animals the richest in mental endowment, has the greatest proportion of brain*; and between these extremes, the gradations are probably as numerous as the species†. The general division of the human brain is into *cerebrum, cerebellum*, and *medulla oblongata*. Each of which, or at least, something similar, is observable in other animals. Names have been invented and assigned by anatomists to many subdivisions. In fishes these subdivided portions are more distinct, as well as more numerous than in man. It should seem therefore, that intellect depends rather on the size of the whole, than the number of the parts. In the human brain four cavities are found called ventricles, communicating with each other, and containing more or less fluid. Similar cavities, but differing in size and number, are observed in the brains of all other animals: they are perhaps essentially necessary to render the organ complete.

THE

* The human brain is twenty-four times heavier in proportion than that of an ox. Monro on the Nervous System, c. viii. 25.

† The reader is referred to the numerous plates of the human brain already published, particularly to Vicq. D'Azir. Traitè d'Anatomie et de Physiologie avec des Planches coloriees, &c.

The brains of Quadrupeds differ from the human brain, not only in proportional magnitude, but in form and consistency. The form of the brain being determined by that of the inclosing *cranium*, is less spherical in them than in man. It's consistency, even when it is recent and undisturbed, is not so firm in the latter as in the generality of Quadrupeds, and the difficulty of dissection is proportionally increased*.

In the human subject, the *cerebrum* and *cerebellum* are separated by a strong process of the *dura mater*, called *tentorium:* in many animals part of this *septum* is formed by processes from the bones of the skull†; and to these, that part of the *dura mater* which forms the membranous portion of it, is attached, and occupies only the central part. Anatomists have supposed, that the violent motions of many animals rendered greater precaution necessary in them, than in man, to prevent concussion of the brain, by the impact of one part on the other. If this conjecture be well founded, those animals, which bear their weapons of offence and defence on the head, ought to have a stronger and more osseous *septum*, than such as contend with the hoof, teeth, or claws; it does not appear that any such difference takes place in nature; the bony portion of the *septum*, is neither so extensive, nor so strong in the deer, as in the horse or dog.

The structure of the brain in Birds, is by far more simple; and it's divisions less numerous. In other respects it is analogous to that of the foregoing class.

The brains of Fishes consist of a multiplicity of parts: and are on all sides closely invested by the *pia mater:* between which

* I am aware that a contrary opinion has generally prevailed. I speak from my own observation.

† Vid. Tab. xiv.

which and the *dura mater* is interposed a fluid of different density in the different species*. Lymphatics, for the absorption of this fluid, have been described, and figured by Monro. The absorbents of the human brain have not yet been demonstrated: but from analogy we infer their existence; particularly in the ventricles.

The quantity of Blood, circulating through the brain, has attracted the notice both of antient and modern Anatomists; and though their calculations disagree, it is allowed by all, to be much more† than proportionate to the mass through which it circulates. This circumstance has induced some authors to describe the brain as one large gland, of which the nerves are to be considered as excretory ducts. Their opinion is not supported by reason, analogy, or experiment: a work of greater importance is performed by the brain, than the mere separation of something from the blood. Why then is so large a portion of this essential fluid directed thither? This question has not hitherto, and possibly never will receive a satisfactory answer. Though a large determination of blood to the brain is indispensably necessary to prevent *deliquium*, yet the proper quantity cannot be much exceeded without considerable danger. And not only the quantity, but the velocity of the circulating fluid is limited. Beyond a certain point an excess or deficiency of either is fatal.

As health is dependant both on the quantity and velocity, the effects of an increase or diminution of the one, may be, in a great degree, counteracted, by diminishing or increasing the other. *Deliquium* from loss of blood is removed by a horizontal posture; the *delirium* of inflammatory fever by venesection: it is a curious fact

* Monro, in his excellent Treatise on the Anatomy of Fishes, has figured and described a numerous assemblage of spheroidal bodies loosely connected with the brain, but closely with the nerves, in the Cod, Haddock, &c.

Monro Anat. of Fishes, Tab. xxxi. xxxii. xxxiii.

† Malpighius calls it one third of the whole. Haller, one sixth, &c.

fact, that in two circumstances of such essential importance, an approximation to health should depend upon the imitation of the healthful *momentum*.

As the excess of *momentum* is fatal, the wisdom of the Creator has by peculiar contrivances retarded the blood in it's progress to the brain. In the erect position of man, besides it's ascent in opposition to the power of gravity, it passes through the very extraordinary flexures of the internal carotid, and vertebral arteries. The joint efficacy of gravity, and friction must be very considerable.

In the ruminating Quadrupeds, the blood is not retarded in it's passage to the brain, by the position of the body, and is even accelerated by that of the head, while the animal is feeding. To obviate the effects of too violent an impact, the arteries, instead of having their trunks simply bended, as in man, are divided into an incredible number of small and sinuous ramifications, within a cavity of the bone, which are again united in one tube, before they pass into the cranium, to be distributed on the brain*. In this admirable structure, the minuteness, as well as the convolutions of the branches, contributes to produce the remora required†.

If

* Vid. Tab. xii.

† This beautiful plexus of vessels was known to Galen, who gave it the name of *rete mirabile*, although he appears to have been ignorant of it's use. In some of the herbivorous Quadrupeds, as in the Horse, and the Ass, a different apparatus is employed to effect a similar purpose. The carotid arteries in these animals do not separate into a multiplicity of branches to be again united, as above described; but dip down into deep cavities or *fossæ*, which communicate with each other by several transverse branches. Willis assigns a curious reason why nature should have substituted this structure for the *rete mirabile*. After having described the course of the internal carotids in the horse, he says, " Quod equidem ita fieri oportuit, *quoniam huic animali quasi ad bellum et pericula quævis aggredienda nato*, magnanimi et feroces impetus conveniebant, adeoque opus erat, ut sanguis libero ac uberiori decursu, et (si quando occasio requirit) pleno

 torrente,

If a diminution in the quantity of the circulating fluid produce *deliquium*, a total though momentary interruption of it must be attended with considerable danger. The essential continuity of current is secured by the magnitude of the principal arteries, and their proximity to the heart.

In many parts of the human body, there is a temporary stoppage in the veins, caused by the pulsation of the neighbouring and corresponding arteries: such obstructions in the brain are avoided, by the extraordinary structure of the larger venous trunks called *sinuses;* which are not, as elsewhere, cylindrical, but prismatic, having their angles kept on the stretch by the peculiar mode of their attachment to the *cranium:* so that they neither yield to the force of the surrounding pulsation, nor are they compressed by the superincumbent weight of the brain: by this singular conformation, the refluent blood suffers no obstruction in it's return to the heart.

The Nerves, which proceed immediately from the brain, are greater or smaller, as the sense, to which they are subservient, is more or less acute; with little, if any, reference to the size of the brain itself, or of the animal, to which they belong*; so that by inspecting these nerves only, the Anatomist may be enabled to form a very probable conjecture of the comparative excellence of all the senses, with which an animal is endowed.

The nerves, which derive their origin from the spinal marrow, have a twofold office assigned to them by nature; they not only constitute

torrente, cerebrum ascenderit. In ove, vitulo, porco, immo in cane, vulpe, fele et cæteris quadrupedibus quos hactenus dissecare contigit, hæc arteria in plexus reteformes divaricatur, &c." Willis Anat. cereb. p. 103.

* The optic nerve passing to the comparatively small eye of the Elephant, is no larger than the nerve going to the human eye; but the nerves which arise from the *medulla spinalis* are in proportion to the size of the animal.

constitute the universal sense of feeling, but are likewise the indispensable agents of all animal action, whether voluntary or involuntary. Their existence is manifested in the minutest portion of the largest body; and as the necessity of feeling, of performing certain functions of the animal œconomy, and of possessing the power of locomotion, is common to creatures of every dimension, the magnitude of these nerves bears no certain proportion to the size of the brain, and is regulated only by the bulk of the animal.

SECT. III.

OF THE OLFACTORY, OR FIRST PAIR OF NERVES.

THE Olfactory Nerves in the human subject, take their rise from the *corpora striata**; and directing their course towards the cribriform process of the æthmoid bone, are there suddenly divided into many branches, extremely difficult of examination, on account of their delicate and pulpy texture†. In this divided state, they pass through the numerous perforations, which have given a name to the part, and are then distributed on the organs of smell.

IN some Quadrupeds these nerves are hollow, till they approach the sievelike process; where the cavity is completely closed‡. This circumstance

* Authors differ somewhat on this head, from the great difficulty or rather impossibility of determining the precise point of the brain, at which they have their origin. See Winslow, Willis, Vicq D'Azir, &c.

† Monro's Observations on the Structure and Functions of the Nervous System, Plate xxiv. Fig. 1.

‡ Idem, Plate ix. Fig. 2. 3.

circumstance escaped the observation of the antient Anatomists, who mistook them for ducts of communication between the brain and the nostrils*, and believed that similar passages in the human subject, performed the similar office of emunctories to the brain†. The greater accuracy of modern science has detected the original error. Monro very properly denominates them the ventricles of the olfactory nerves, and describes their communication with those of the brain‡, of which indeed they seem to be nothing more, than appendages.

In all Quadrupeds, as well as in man, the olfactory nerves begin to ramify within the cavity of the skull; and the numerous branches make their exit through corresponding foramina in the æthmoid bone. In birds and fishes, on the contrary, they pass undivided through the bone by two apertures only, and their separation commences on the outside of the cranium. Their relative magnitude is much greater in the carnivorous Quadrupeds, than in the vegetable eaters; the difference is observable even before they quit the encephalon§. The superior acuteness of this sense in the former is a fact well established, and must in part be attributed to this cause. In the granivorous birds these nerves are extremely small; and as the natural food of the tribe has but little odour, we find them easily deceived by any thing which bears resemblance to it||.

Birds

* The Anatomy of the antients was principally derived from the dissection of other animals, and applied to man by analogy alone.

Hippocrates boasted that he had once seen a human skeleton.

† Ἔσωθεν μὲν ἔνι ἔξω διὰ τῶν κατὰ τὰς ῥῖνας πόρων τὰ περιτλώματα (ἐγκεφάλε) φέρεται ——

Intus igitur foras per narium meatus excrementa (sc. cerebri) efferuntur.

Galen Lib. viii.

‡ Monro on the Nervous System, Tab. ix. Fig. 1.

§ Derham's Physico Theology. p. 140. Note 6.

|| While the Author was writing these remarks, some poultry, which were usually fed with a mixture of barley meal and water, were found to have swallowed nearly the whole contents of a large pot of white paint. Two of them died, and two others became

Birds of prey, on the other hand, are allured by the scent of carrion from a distance of many miles; from this circumstance alone we might safely infer, that their olfactory nerves were proportionally large—dissection proves them to be so.

THE fishes are all of them animal eaters, and the great size of these nerves is a striking part of their anatomy: the element, which they inhabit, as well as the nature of their prey, renders extreme acuteness of this organ essential to their existence.

IF the structure of the olfactory nerves were exactly similar in all animals, that is, if the single and individual fibres, composing the fasciculus, were of the same magnitude and sensibility; if, besides, they were distributed on the *olfactory membrane* at certain regulated and invariable distances, it would follow, that the space occupied, and consequently the acuteness of the organ, would vary in a duplicate ratio of the diameter of the nerve*. But we must not rely upon any conclusion drawn from such uncertain principles. The nerves themselves are evidently dissimilar in structure; and we cannot trace them to their ultimate ramification. We have therefore no right to conclude, that their sensible extremities are arranged on the membrane, in a fixed and invariable order.

HOWEVER, till some better mode be discovered, we must be content to estimate the acuteness of the sense by the superficial content of the olfactory membrane. With these precautions, we proceed to examine the organ of smell in the different classes of animal existence.

SECT.

came paralytic. The crops of the latter were opened, and considerably more than a pound of the pernicious mineral composition taken from each. The crops, either naturally, or from the saturnine quality of the paint had very little sensibility; the wounds were sewed up, and both of them recovered.

* The diameter might be taken with sufficient accuracy by a micrometer.

SECT. IV.

OF THE HUMAN NOSE.*

THE *septum Nasi*, formed by a descending portion of the *æthmoid* bone, and the *vomer*, divides the nose into two distinct cavities; within which the †*Conchæ superiores* and *inferiores* are situated. They are simple in their form and but slightly convoluted. The two cavities reach backwards as far as the arch of the Palate; where, by their posterior openings, they have free communication with the Mouth, the Pharynx, and Larynx, in a word, with all those parts, upon the separate and combined actions of which depend, the various faculties of tasting, swallowing, and breathing. With these cavities, several others (called sinuses) have connection. Canals of communication pass from the eyes to the internal nostrils; through which, in a healthy state, the tears descend from the former to the latter.

ALL the internal parts of the Nose are covered with a soft thick membrane, plentifully supplied with blood vessels. Upon that part of this membrane, which lines the internal *nares* properly so called, *and probably on that part only*, the ramifications of the olfactory nerves are distributed.

As this opinion differs from that, which Anatomists have generally maintained, it is incumbent on me to assign the reasons which have induced me to adopt it.

1*st.*

* It would be foreign to my purpose to say any thing concerning the external form of the nose — I shall pass over very superficially many other circumstances concerning which the medical Physiologist may consult a variety of anatomical writers, whose business it has been to enter more particularly into the minutiæ of it's structure.

† These bones have been termed indiscriminately *conchæ*, *ossa turbinata*, *ossa spongiosa*, &c. — The Author, for the sake of greater precision, when he speaks of them generally, as existing in the various classes, has ventured to call them simply *olfactory bones* — When in particular of man, *conchæ* or *conchiform* — when of herbivorous quadrupeds, *turbinated* — when of carnivorous, *ramified*.

1*st.* The branches of the nerve have been traced so far by Hunter, Monro, and other Anatomists, but no farther. It must therefore be doubtful, at least, whether they extend to the continuation of the membrane, in the surrounding cavities or sinuses.

2*nd.* If the external apertures of the nose be obstructed, we have very little, if any, perception of scents, although the air has free access by the posterior openings*. From which we may infer, that the odoriferous particles must not only come into contact with, but be applied successively, and in current to the membrane, before sensation is produced. Now as the *sinuses* communicate with no other part than the nostril, each of them by a single aperture, and that a small one, it is not possible to conceive, that the stream of air, diverted from its natural course, should make a circuit of the cavity, at the same instant passing, and repassing, in opposite directions, through the narrow channel.

3*d.* When sneezing is produced by any preternatural stimulus on the olfactory nerves, it may be suspended by pressure on the external alæ of the nose. This pressure affects the internal *nares*, not the cavities.

4*th.* The peculiarities of structure, which, in other animals, extend the surface of the olfactory membrane, are distinct from, and unconnected with the sinuses.

Though the opinion, generally entertained concerning the use of these cavities in improving the olfactory powers, be rejected, it is not difficult to assign to them probable, and important offices. They are subsidiary to the vocal organs, and while they increase

* Animals, who are under the necessity of providing for their subsistence by their faculty of smelling, constantly breathe through the nose; which habit being natural to them, it is with great constraint and difficulty, that they can respire through the mouth, when the nose is forcibly held. Let any one try the experiment of holding a dog's nose, and he will be convinced of the truth of this observation.

increase the loudness, they improve the tone also of the various modulations, which are necessary for the communication of our ideas. The disagreeable alteration of the voice, produced by a stoppage of the nose, sufficiently proves the truth of the observation.

A SECOND and more beneficial purpose, attributed to them, by the almost general consent of anatomists, is the separation of a mucous fluid, for lubricating the internal nares*: the extremities of the olfactory nerves are slightly covered, and require some defence, against the acrimony of the many volatile substances, which they necessarily encounter. Their action likewise would probably be impeded by dryness. The preventive efficacy of the mucus is essential for both purposes. It is not probable, that the inconsiderable surface of the nostril could secrete this fluid in sufficient quantity; but the cavities amply supply the deficiency; and in them likewise, the secerned fluid is submitted to the action of the absorbent vessels, and thus it's consistency is perfected. The necessity for this process is indubitable: for when the secretion is too rapid, (as in the catarrhal discharge,) and the fluid is poured on the nostrils, without due preparation, and absorption, sneezing, inflammation, and sometimes excoriation of the parts, are unequivocal tests of acrimony.

WE shall now proceed to the Quadrupeds of the class *Mammalia*, and examine the conformation of their nose, and olfactory bones; on the latter of which, the acuteness of the sense seems principally to depend. The structure of them differs widely in the different tribes. In the same tribe, the general resemblance is strong: yet in each species, certain peculiarities are discoverable, which probably constitute their several degrees of sagacity.

SECT.

* Vid. Note on the frontal Sinus of the Sheep, in the next Section.

SECT. V.

OF THE NOSE AND OLFACTORY BONES OF THE HERBIVOROUS QUADRUPEDS.

IN all animals * of this denomination, there is an evident similarity in the structure of the olfactory bones; notwithstanding specific varieties, one general model has served for the fabrication of all: their form is †*turbinated.*

The Hog, which in it's natural state subsists altogether on vegetables, sufficiently resembles the vegetable eaters, in the external form, and proportionate magnitude of these bones, which however in the simplicity of their internal structure, bear a still nearer resemblance to those of man ‡.

IN the Horse §, the turbinated bones are of considerable diameter, and great length, reaching nearly from one extremity of his nostrils to the other: their structure is curious and intricate; externally they retain the general form of the oblong spiral shell; but

* It cannot be reasonably supposed, that the Author should have dissected all the genera and species of the herbivorous tribe. As far as he has had an opportunity of examining them, this observation holds good.

† The *herbivorous* animals were those, best known to the antients by dissection; they denominated the olfactory bones of this tribe, *ossa turbinata*, with peculiar propriety: the term has been applied by analogy, to the conchæ of the human nose: it is only by abuse of language, that similarity of office, can be denoted by a word significant of form.

‡ They are formed of single plates, slightly convolute, and destitute of perforations or partitions. Vid. Tab. XIV. Fig. 1. G. H.

§ Vid. Tab. XIV. Fig. 2. E. F.

but are pierced on all sides with numerous perforations *, through which the membrane, together with the fine branches of the nerves, passes freely from one side to the other; they are convoluted †; and the cavities are intersected, at distances nearly regular, by unperforated partitions of extraordinary tenuity; serving as well to support the arch of the bone, as to afford still greater surface for the extension of the olfactory membrane ‡. The superior turbinated bone of this animal, is larger and longer than the inferior §.

In the Sheep, the Goat, and the Deer, the lower bone exceeds the upper both in length and diameter ‖ — the convolutions in it are double, with a septum between; a transverse section bears some resemblance to the capital of the Ionic column ¶. In all these animals, the perforations throughout the bone, are very numerous, and continued through the whole of the convoluted portions, as well as through the septa, with which, like the horse, these animals are furnished.

The number of perforations is greater in the sheep than the horse; in the goat than the sheep; in the deer than the goat. In the deer they are so excessively minute, as to vie with the finest lace in elegance and delicacy of fabric ⸸. Over the whole of this osseous network, the olfactory membrane is distributed; from the internal lamina of which, every bony fibril is supplied with a distinct nervous covering **.

The ††olfactory bones of the Elephant are apparently smaller in proportion than the human. The defect in this part is abundantly

* See Tab. IV. C. F. † Tab. IV. F. ‡ Tab IV. E E E E.
§ Tab. XIV. Fig. 2. E. ‖ Tab. XIV. Fig. 3. D. E. ¶ Tab. III. A B.
⸸ Tab. XIV. Fig. 3. E. ** Vid. Tab. III.

†† The Author cannot at present determine whether the olfactory bones of the Elephant are *conchiform* or *turbinated* — having hitherto had the power to examine them in

 situ

dantly compensated by the extraordinary length of his nostrils, which are continued through the whole extent of his Proboscis*, a machine wonderfully adapted, to supply the exigences of this unwieldy animal, by its various powers.

In addition to the turbinated bones, the ethmoidal processes afford a considerable surface for the extension of the olfactory membrane, in all these animals. There is, however, a very remarkable difference in the structure of them. In the Hog, and Horse, they do not partake of the turbinated form, but ramify; with this difference, that the branches are more numerous, and minute in the former, than in the latter†. In the Sheep, Goat, and Deer, they resemble the other olfactory bones, both in their convolutions and perforations‡.

Passing from the parts immediately concerned in the sense of smelling to those which are only subsidiary, we find considerable variety in the magnitude, and number of the sinuses of this class. Compared with the same part in other animals, the frontal, and maxillary sinuses, are of great magnitude. In the hog, the former is not proportionally so large as in the goat, and sheep§. In the Horse the latter is comparatively spacious.

The

situ only— he is happy in this opportunity of acknowledging his obligations to Dr. Baillie, by whose indulgence he is enabled to lay two plates of the Elephant's skull before his readers. Tab. VI. and Tab. XV.

* Tab. V. A A. † Tab. XIV. Fig. 1. F. ‡ Tab. XIV. Fig. 3. C.

§ The extraordinary size of this sinus in the sheep's skull, renders it a convenient lurking place for the *Œstrus Nasalis*, or Gadfly, the female of which creeps up the nostril, and deposits her eggs there. The animal heat forwards the hatching of the eggs, and when the maggots are produced in great numbers, (which frequently happens,) the nose of the sheep becomes dry, for want of the mucus, which these insects devour for their sustenance; by their incessant motion, and the consequent irritation of the parts, a fatal disease is occasioned; one of the principal symptoms of which is *vertigo*. For the cure of this disorder, it is no uncommon practice with the shepherds, to break a hole

 into

The Deer has the maxillary, but not the frontal sinus. This animal is distinguished by a peculiarity of formation, which may probably be conducive to the subtilty of the organ of smell. Between the internal angle of the eye, and the ridge of the nose, there is a space irregularly quadrangular, over which a strong membrane is spread, and performs the office of bone, in covering, and protecting the cavity beneath. This cavity does not communicate with the nostril by means of a small aperture, as is usual in the sinuses of other animals, but is intirely laid open to it, through it's whole extent, which is portioned out into different cells, by bony plates, either perforated or reticulated. Similarity of structure, and unimpeded connection, leave but little doubt concerning the use of the part. The intention of Nature, in supplying it with a membranous, rather than a bony covering, is not so evident.

The holes at the anterior extremity of the upper jaw, passing from the nose to the mouth, are extremely large in all this tribe, from which circumstance we infer, a stronger connexion between the nerves of the nose and palate, and consequently a more intimate correspondence between the olfactory and gustatory organs.

The dissection of many other animals belonging to this class, has produced nothing worthy of remark. — Varieties in the comparative size of the turbinated bones, in the number and magnitude

into the sinus, by means of a chisel and mallet, and then to remove, or to destroy the noxious inhabitants. In this unskilful operation, the danger of fracture is obvious. — Instead of such clumsy instruments, the rural œconomist would find his advantage, in directing the application of a simple trephine, similar to that which is used by Surgeons in trepanning the human skull. By this instrument, the operation would be performed with less trouble to the operator, and much less pain to the animal; the intention would be equally answered, and the risque of a fracture be avoided. I have been an eye-witness to the success of this practice, and have no doubt, that the general introduction of it, would be extremely beneficial, both to the farmer, and to the public.

tude of their perforations, the manner in which their convolutions are made, the scarcity or abundance of the transverse plates, might be noted down with scrupulous exactness; while many circumstances cognizable by the eye, but too minute for description, must necessarily be omitted.

The result of the whole is a conviction, that the turbinated bones, are a characteristic distinction of the herbivorous Quadrupeds.

SECT. VI.

OF THE NOSE AND OLFACTORY BONES IN THE CARNIVOROUS QUADRUPEDS.

THE carnivorous Quadrupeds next present themselves to our view. The nasal sinuses of this division afford nothing which can delay the investigator, being either very small or altogether wanting. The frontal sinus is evident in the feline, and canine tribes*. In the Seal it can hardly be said to exist.

OUR attention is then naturally directed to the olfactory bones; the formation of which in the vegetable eaters, is as curious as their office is important. It is not without surprize, that we discover a fabric, greatly differing from the *turbinated*, more complicated in it's structure, and affording a far greater surface for the distribution of the olfactory nerve.

AT the head of this class, we shall place the Seal; in which animal, a bone of very intricate structure, occupies nearly the whole

* Vid. Tab. XIII. Fig. 2. C. Tab. II. B.

whole of each nostril. When viewed in front, it resembles that section of the brain, which has obtained the name of *arbor vitæ**. The principal trunk† is attached to the rising arch of the maxillary bone, and directs it's course downwards, till it approaches, within one third of it's length, to the *os palati*. Eight or more principal branches, arise from this trunk, each of them is afterwards divided and subdivided, until the eye is weary in following them. More than one hundred minute ramifications were counted on one of the eight, by no means the most considerable in size. The whole number was probably greater.

On viewing the bone in profile, it appears that these ramifications, are not merely osseous spiculæ, but the minute edges of bony plates of exquisite tenuity, about one inch in length, and one twentieth of an inch in breadth. These laminæ, passing backwards, and probably subdividing themselves before their reunion, terminate in a bone, which is situated in the back part of the nostril, and is of a structure similar to that of the main trunk‡. By removing the whole of this complex fabric, it will be found, that it's attachment, is by one principal rib, which begins at the insertion of the large trunk into the arch of the maxillary bone§, and is continued to the convex surface of the orbit of the eye, where it divides into three or four smaller ones. The extreme ramifications approach very closely to the *septum*, the *os palati*, the *os maxillare*, and the orbit of the eye, but without contact, or other attachment, than by the rib already described.

The olfactory membrane, with all it's nerves, is closely applied to every plate of this astonishing assemblage, as well as to the main trunk, and to the internal surface of the surrounding cavity.

It

* Tab. I. † Tab. I. E. ‡ Tab. XIII. Fig. 1. G. § Tab. XIII. Fig. i. F.

It would be extremely difficult, not to say impossible, to calculate the superficial content of the membrane. We may venture however to state, that it cannot be less than one hundred and twenty square inches in each nostril*.

This animal has the peculiar faculty of closing the orifice of the nostril at pleasure. An organ of such exquisite sensibility seems to require an extraordinary power of securing itself from injury, by the voluntary exclusion of noxious particles.

In the Cat, the ramified bones, though bearing a general resemblance, are specifically different from those of the seal†; when viewed in front, the ramifications are found to be less numerous, nor can they be traced, with the same distinctness, to a central trunk; when viewed in profile, the lamellæ are not straight, as in the last mentioned animal‡, but bent, and somewhat convoluted; they terminate however in a posterior bone, and have a similar attachment by a main rib to the maxillary bone.

In the Fox and the Dog, these bones (in conformity with the shape of the head) are longer, in proportion to their diameter, than in the Cat; the ramifications are more convoluted, and the whole system is gently bent into a spiral. Their attachment is the same in every respect as in the last mentioned animal§. The space allotted to the ramified bones, in the Cat, Dog, and Fox, is about half the cavity of the nostril; the remainder is occupied by

* If we take 100 as the average number of lamellæ on each branch, the whole number will be 800; and the two surfaces of them will be represented by 1600; to this we must add at least 800 for the surface of the remaining portions of the ramified bone, and the cavity; in all 2400 surfaces of about one inch in length, and one twentieth of an inch in breadth. This statement is certainly below the truth.

† In the Polecat, the Weasel, &c. this resemblance is much stronger.

‡ Tab. XIII. Fig. 2. E. § Tab. XIII. Fig. 3. D. E. Tab. II. E.

by the ethmoidal processes, which in the carnivorous tribe, vary not less, than in the herbivorous. The Seal may be said to possess the rudiments of them, rather than to have them in reality. The magnitude of it's eye is such, that a very small space intervenes between the convex surfaces of the right and left orbit; and in this space, the processes may be traced*.

In the Cat, they assume a very different form; externally resembling the turbinated bones of the herbivorous Quadrupeds†; if examined internally, their numerous and intricate convolutions, approach very nearly to the ramified structure.

In the canine species, for a reason already given, they extend to a great length, with the character of *turbination* more strongly impressed on them‡;—their convolutions are most perfect near their origin; as they recede from the ethmoid bone, the ramified structure becomes more and more apparent§.

SECT. VII.

OF THE OLFACTORY ORGANS IN BIRDS.

THE distance, which Nature has placed between Quadrupeds and Birds, with respect to their exterior conformation, and evident habits of life, should seem to denote, but little correspondence of interior structure. A nearer inspection, however, discovers many circumstances of no very distant resemblance, and some even of close analogy will present themselves to our view.

The

* Vid. Tab. XIII. Fig. 1. D. † Tab. XIII. Fig. 2. F F.

‡ Tab. XIII. Fig. 3. F. G. Tab. II. F. § Tab. II. C.

THE olfactory nerves are, in this class also, the first pair sent out from the brain. They do not however make their exit, by the perforations of a sievelike process, but pass undivided through separate holes; they are of a loose, and pulpy texture, not to be traced by dissection, and are presently diffused, so thinly, on the nostril, as to escape the eye; nor do they become visible, until they reach the more distant parts of the olfactory membrane, where, in some instances, their ramifications are distinctly seen*.

BIRDS, whether *carnivorous*, *granivorous*, or *omnivorous*, have something analogous to the superior, and inferior turbinated bones; which, in their general form and situation, differ but little from those of the herbivorous quadrupeds; in some birds, their substance is cartilaginous, as in the Buzzard, and Turkey, and their convolutions approach more nearly to a regular spiral†: in others, they are rather membranous, than cartilaginous, as in the Cassawary, Albatross, &c. but are always situated near to the external openings, which are placed, not like the corresponding parts of quadrupeds, at the extremity of the head, but are removed to a distance, more or less considerable, from the end of the beak. The intention of Nature, in suffering the analogy to fail in this particular, is too evident to need a comment.

IT is not, therefore, to any difference in the conformation of this part of their olfactory organs, but to the quantity of nerve, with which the organ is supplied, that we must attribute the superior acuteness of this sense in the carnivorous, to that of the granivorous tribe.

IN the proportional size of the true olfactory nerves, there is but little difference; they are comparatively small in all the species, and their distribution in the granivorous birds, is confined to

* Tab. VII. Fig. 3. B. † Tab. VII. Fig. 1. C. Fig. 2. A.

to the membrane, which composes, or surrounds the turbinated structure, and lines the inside of the nostrils; the extent of which is in none of them very considerable.

ANOTHER pair of nerves (which from it's magnitude, and office, has been mistaken by the older Anatomists for the first pair*; and which in the granivorous birds, is analogous to the nasal branch of the fifth pair in the human subject,) is in the carnivorous tribe of much higher importance, being not only a subordinate, but necessary auxiliary to the olfactory nerves.

IN the Duck, they are most conspicuous, both from their size, and mode of distribution †. In this bird they originate in the *medulla oblongata* ‡, and presently divide into two large branches, which, after they have passed through the orbit of the eye by separate *foramina* §, take their direction downwards, and spread over the mandibles, both within and without; their elegant ramifications terminate towards the edges, and are covered by a tough, thin, and almost transparent membrane, soft and smooth as polished leather. A similar, but finer membrane lines the inside of the bill.

THAT no injury may be sustained by the sensible nervous papillæ, from the application of hard bodies, a horny process ||, similar to the human nail, in form as well as office, is placed at the extremity of the beak, the edges of which are guarded by a narrow

* Vide Collins Anat. Tab. lvi. lvii. lviii. and lix.

† In the Swan, Goose, Woodcock, Curlew, and Snipe, the distribution of these nerves, varies according to the form of the beaks, which is different, for the purpose of affording some distinct accommodation to the animals.

‡ Tab. VIII. Fig. 3. C. D. E. § Tab. VIII. Fig. 1. C. H. Fig. 2. C. D. F. F. &c.

|| Tab. VIII. Fig. 1. F.
At the extremity of the Albatross's beak there is likewise a strong horny production.

narrow border of the same substance; these receive a first, and fainter impression, and admonish the animal of approaching danger; if none occur, the matter is then submitted to the immediate scrutiny of the nerves themselves, and swallowed, or rejected, according to their indication.

THE beak of the Duck, and the bone analogous to the ethmoid of Quadrupeds, are both of them cellular *; and on every portion of their spongy bodies, nervous fibres are distributed. It is not possible to trace these minute and tender branches to their origin, and decide whether they belong in part to the true olfactory, or solely to the auxiliary nerve. May we venture to conclude, that the ramifications of both are indiscriminately spread upon the cells? This is at least probable; and throws additional light upon the comparative structure of the carnivorous, and granivorous tribes. The beaks of the latter, are hard, and solid; and the surrounding bones are composed of thin osseous plates without the interposition of a spongy substance †. The beaks of many of the former, are still more hard, and strong, for the purpose of tearing their prey; but the surrounding parts abound in cells ‡; in the one, no space is given for the distribution of the auxiliary nerve, had it been larger; in the other, the open texture affords an ample surface for it's extension §, and the air has not only free access to it; but may probably be directed in current, through every cell in it's passage to the lungs.

IN

* Tab. VIII. Fig. 1. I. Fig. 2, I.

† Tab. VII. Fig. 1. A. ‡ Tab. VII. Fig. 2. C.

§ The auxiliary nerves in the granivorous birds, are very minute. Tab. VII. Fig. 1. B. B. In the birds of prey, they are comparatively large. Tab. VII. Fig. 2. B. B. And in such as search for their food in bogs, &c. they are of an astonishing size. Tab. VIII. Fig. 1. 2. 3.

In the noses of the Eagle, the Pelican, the Albatross, the Hornbill, the Cassawary, and many others, which I have carefully dissected, Nature has made an extraordinary provision of cells for the distribution of the nerves. The large protuberance on the head of the Cassawary, which Buffon calls *le casque conique*, is evidently intended by Nature for the greater expansion of the nerves *. It is composed of bony fibres, curiously reticulated, and of considerable extent, and communicates immediately with the nostrils, the external openings of which are nearer to the end of the beak, than in any other bird, and are supplied with a turbinated, or convoluted membrane, upon which the true olfactory nerves are spread.

The inside of the large protuberance on the beak of the Hornbill, and also the whole of the upper mandible, are furnished with one continued network of bony fibres, covered with a sensitive membrane, to which the external air has immediate access through the nostrils, which are situated at the upper part of the beak, near the internal angle of the eye, and which from their deficiency in point of size, and extent, can afford but a very narrow space for the expansion of the olfactory membrane. Similar bony *cancelli*, are observable in the upper mandible of the Albatross, whose nostrils are in a similar situation. The same observation would hold good with respect to many other birds, which it would not be consistent with the brevity of my plan to enumerate.

I therefore conclude, that to the greater aptitude of the cellular structure for the expansion of a sensitive membrane, and to the greater magnitude of the auxiliary nerves, the carnivorous tribe are indebted for their acknowledged superiority of smell.

* Buffon attributes no use to this extraordinary appendix, although he takes notice of it's structure, and connection with the bones of the skull. " *Ce casque est formé par le renflement des os du crâne, en cet endroit, et il est recouvert d'une envellope dure, &c.*
Vid. Buffon Hist. Nat.

SECT.

SECT. VIII.

OF THE OLFACTORY ORGANS IN FISHES.

WE now proceed to examine the olfactory organs in a class of animals, which are not only very far removed from the two former, with respect to their external, and internal structure, but destined to inhabit a different element, and to have their senses acted upon through a different medium.

In Fishes there are no cavities or sinuses communicating with the nostrils—a strong confirmation of the general opinion of Physiologists concerning their use, and importance to men, and quadrupeds. Beneath the water, they would have been ineffectual for the propagation of sound, and unnecessary for the supply of a lubricating mucus.

The olfactory nerves of this division are of great relative magnitude, and pass through the bone in two undivided cords*. They are also far more firm, and cohesive in their texture, than the corresponding nerves of the other classes, and may be traced with ease, through the greatest part of their extent. The situation of the brain, and it's distance from the seat of this sense, differ so widely in the different *genera*, that no description of the course of the olfactory nerves can be applicable to all. In some, they proceed by a short and direct rout; in others, they traverse a considerable space, before they arrive at the place of their destination.

They are minutely ramified upon a membrane, in this, as well as in the other classes; but the attachments of the membrane, and the distribution of the nerves upon it, are of a distinct kind. Nothing similar to olfactory bones, either *ramified*, *turbinated*, or *conchiform*, can be traced. In those fishes, which I have examined, the expansion of the membrane is effected by means of tendinous ligaments, or cartilaginous *septa*, variously disposed.

In

* Tab. IX. Fig. 2. F F. K K. Tab. X. Fig. 2. 2.

In the Skate-fish, the olfactory nerves are by far the largest, that arise from the brain; they have their origin from the anterior and largest lobes*, and swell to still greater size, immediately after they have traversed a cavity, situated in the fore part of the cranium, and filled with a viscid fluid†: they afterwards pass into the nose, and are infinitely dispersed on the olfactory membrane.

This membrane, which is of a dark colour, resembling the *choroid coat* of the eye, is disposed into two series of parallel laminæ; each of them inserted (like the teeth of a double comb) into a middle cartilaginous *septum*, or rib, which serves at once to keep them on the stretch, and to connect the two series together‡. The *laminæ*, of which the edges only are visible in situ, are about an inch and a half in length, and an inch in breadth, and consequently expose a very considerable surface to the water, which passes in a current through every interval, in its way to the throat and gills. An elastic cartilaginous *operculum*, is placed at the orifice of the nostril, to protect this delicate structure from external injury §.

The fifth pair of nerves, which in most animals contributes it's share of energy to the nose, is in the Skate a powerful ally; sending considerable branches to accompany the ramifications of the true olfactory nerves; and others, of equal, or superior magnitude, to the end of the snout, with which this animal turns over the sand, in search of its proper food ||.

In the Pike, the olfactory nerves arise from the anterior lobes of the brain¶, and, passing over the optic nerves, run parallel to each other about one third of their length; they then separate, and take their course to their respective nostrils**. Before their arrival,

* Tab. X. 2. 2. 3. 3.
† Tab. X. 1. Vid. Monro's Structure and Physiology of Fishes. Tab. xxxiv. I.
‡ Tab. XI. D. E. § Tab. XI. F. || Tab. XI. C. G. H. I.
¶ Tab. IX. Fig. 2. E. E. ** Tab. IX. Fig. 2. K. K. L. M.

arrival, the fibres separate very minutely, and are arranged parallel to each other, like the hairs of a pencil, to be spread at large on the olfactory membrane*, which is folded into several doublings, connected together in the centre, from which the *plicæ* proceed, like radii towards the circumference. In this position, they are kept firm and steady by the cartilaginous border that surrounds them; instead of being divided into two sets, as in the skate-fish; and afford a very striking example of the mode, in which Nature, by a different process, accomplishes a similar purpose.—The small and elegant ramifications of the nerve, alternating with the blood vessels, may here be distinctly traced, the dark colour of the membrane forming a beautiful contrast with the silvery hue of the nervous filaments. Over this tender structure, a guard is placed, which divides the external opening into two, and gives it the appearance of a double nostril†.

In the Tench, the membrane is simply spread on the cavity of the nostril, and is consequently of very inconsiderable extent. This defect, however, is probably compensated by a curious circumstance in the structure of the nerve itself; which near the extremity of it's course, is arrested by a small spherical body, resembling the medullary substance of the *cerebrum*‡. From this detached lobe the nerve takes a fresh departure, having acquired (it may be presumed) additional powers by it's union with this species of secondary brain§.

Thus

* Tab. IX. Fig. 2. L. L. † Tab. IX. Fig. 2. M.

‡ This little orb is taken notice of and described by Collins (Vol. II. Tab. 63, 64, 66) in the heads of the Cod, the Carp, and the Whiting.—Monro has given a particular description of it in the Haddock, and calls it a spherical *cineritious* body, with which the olfactory nerve is intimately conjoined. *Monro on the Structure and Physiology of Fishes, Tab. xxxi. Fig.* 1. In the Tench it is clearly *medullary*, and the nervous fibres are not to be traced, either upon the surface, or in it's substance.

§ Considerable varieties will probably be found in the olfactory organs of all the different species of fishes. I have judged it sufficient for my purpose, to introduce into this work exact representations of two only. *Viz.* of the Skate and of the Pike.

THUS we see, that the fishes, which are all of them carnivorous, have their olfactory organs abundantly supplied with nerves; which circumstance is sufficient to establish a remarkable analogy between them, and the rapacious orders both of birds, and quadrupeds.

SECT. IX.

OF THE OLFACTORY ORGANS OF AMPHIBIA.

THE paucity of such animals of this class, as are proper for minute investigation, has put us in possession of very few facts concerning their general anatomy. The Turtle indeed has long been an object of physiological enquiry, and many curious circumstances, respecting it's structure, and animal œconomy, have been laid before the world. It's nasal organs, however, have hitherto passed without much notice; for which reason, though my observations may contain nothing of importance, I shall briefly relate, what occurred to me in the dissection of it's nose.

THE olfactory nerves, which have their origin from the anterior lobes of a very small brain, are of great magnitude. They run parallel to each other for the space of an inch, or more, in a deep groove of the bony arch, which forms the upper and fore part of the head, and then pass through two oblong holes, which open into a strong cavity of bone, containing the immediate organ of smell.

WHEN the bone has been with some labour and difficulty removed, so as to expose the inclosed structure, we discover, as in most other animals, a *septum* parting the nose into two cavities; these are lined, on all sides, by a cartilage, covered with

with an intensely black membrane. From the *septum*, and also from the cartilaginous lining, several processes arise, which not only serve for the expansion of the olfactory membrane, but likewise to intercept and arrest, as it were, the odorous particles. One of these processes takes it's origin from the side next the orbit of the eye, and, passing obliquely backwards and upwards, is united to the *septum* on the opposite side, so as to make an obliquely transverse division of the superior, and posterior part of the cavity. A similar process arises from the *septum*, and crosses to the opposite side of the fore part of the nostril, forming a kind of conchiform partition there, and leaving only a small opening opposite to the external nostril. A third process is extended across the nostril, immediately under the external opening, and makes a considerable sinus below that part; so that the external nostrils, which are extremely small (their openings being much contracted by a cartilaginous border) are not at the extremity of the organ, but somewhat higher up.

At the posterior extremity of the olfactory cartilages, there are two considerable openings, one on each side of the *septum*, into the mouth, each of which is beset with a fringe of long papillary productions, stretching quite across it; which, as the animal respires principally through the mouth, may obstruct the passage of extraneous matter passing that way to the nose; the small size of the external orifices being sufficient to defend it from without.

By the inequalities of the transverse *septa*, analogous to the turbinated cartilages of birds, sufficient space for the expansion of the olfactory membrane is provided*.

* Vid. Monro's Anat. of Fishes. Tab. xxxvi. Fig. 1.

SECT. X.

REMARKS AND OBSERVATIONS ON THE OLFACTORY ORGANS OF MAN, AND OF THE CARNIVOROUS QUADRUPEDS.

FROM the foregoing investigation of the olfactory organs of the different classes of animals, we are naturally led to make some reflections on the Anatomy, and Physiology of a *part*, from the variety of whose structure, we should scarcely be induced *à priori* to expect similar effects; especially as we observe them to take place through such different media, as air and water.

THE sense of smelling is less acute in man, than in any animal of the same class. His nostril is relatively small, and the conchiform bones are not calculated to extend the sensitive surface, in any great degree. If, to remedy the defect, we suppose the size of the organ to be increased; and larger or more complex olfactory bones to be substituted, much inconvenience would result from the change. All the advantages which are derived from the spherical form of the head must be forfeited, to say nothing of the incalculable mischief, that would be sustained by the vocal organs. Again, if the nerve itself were endowed with a greater degree of sensibility, man would be subject to many evils from which he is now exempt, and receive no accession of instinctive power, for which experience and reason do not supply an equivalent.

WE conclude, therefore, that this sense is less acute in man, in consequence of the structure of the parts*; that is, by the will of the Creator. Extreme subtilty of smell is essential neither to our

* Willis de Animâ Brutorum, C. xiii.

our subsistence, nor comfort, and has therefore yielded to considerations of greater importance.

In the structure of the nose, man resembles the herbivorous, and not the carnivorous tribe. This circumstance should seem to favour the opinion, that he was intended to subsist upon a vegetable diet. Many phænomena concur to support the opinion. Man distinguishes vegetable odours with great accuracy; he recognizes the various scents of the different plants, fruits, and flowers, and is delighted with their fragrance.

The effluvia of the esculent vegetables are more discriminable before they have undergone culinary preparation. But the raw flesh of the various quadrupeds and birds, which constitute our daily food, affects the sense alike; the difference is scarcely perceptible, and every kind excites disgust. The smell of undressed fish is in general still more repulsive*. When, by the action of fire, these substances have lost their original flavour, they are distinguished with greater ease, and, in this state, might possibly be less offensive to those, who are unaccustomed to animal diet. When they are suffered to putrefy, they are, in the highest degree, loathsome and detestable.

If we note the habits and appetites of the carnivorous tribe, we shall find them indifferent to the true vegetable odours†. As they receive no pleasure from any of them, they do not appear to

* It is remarkable that Oysters, Cockles, and some other shell fish, which are the only raw food of civilized man, are to many persons peculiarly disgusting.

† Hinc canis ad sagienda animalia adeò peritus, rosæ odorem unicè spernit, et violæ, neque eum odorem percipere videtur. Haller Lib. xiv.

to discriminate. Many of them delight in fish, and all of them in blood; and many, if not all of them, are most voracious of carrion.

THERE are, however, some few animal smells, which excite no disgust even in the herbivorous tribe; but, on the contrary, are attended with pleasurable sensations; these either resemble vegetable odours, (as the breath of the Cow) or appertain to some particular animal affections; which last are of two kinds. The one at particular periods directs the male animal to the object and gratification of his desires*; the other, by the delight, which it communicates, attaches the female parent to her young and helpless progeny†. These sources of natural affection seem, in some instances, liable to perversion: and, though the general antipathy to animal food continues, the *placenta*, and even the offspring, are sometimes devoured with great avidity. In other instances, the degeneracy has been still greater, and a carnivorous appetite not only introduced but confirmed‡.

THE acknowledged departure of some animals from their natural and original taste, renders a similar deviation in the human species not incredible; fair and allowable deductions from the anatomy of the part make it probable. Though the olfactory organs of man

* Vid. Darwin's Zoonomia, Sect. xvi. 5.

† When a Lamb dies, it is no uncommon stratagem with Shepherds to strip off the skin and fasten it on the back of another; the mother, deceived by the scent, adopts the alien without hesitation, and cherishes it as her own.

By a similar artifice, unnatural copulations have been procured. The avarice or curiosity of man has induced him to practice a variety of deceptions on the mistaken and degraded animals. Vid. Buffon. Hist. Nat.

‡ I am inclined to believe, that such perversions do not take place in the wild and unrestrained condition of the animals, but are the effects of domestication, and characteristic of a state of degradation and depravity.

man are gratified with vegetable, and disgusted by animal odours; yet, from their unelaborate structure, and the consequent inertness of the sense, the aversion from animal smells was probably conquered, with little difficulty, at a very early period; and animal substances began to constitute a part of his daily food. Artificial tastes may be propagated like hereditary disease or deformity; and it is possible, that, during a long series of *carnivorous* ages, the nose, as well as the teeth*, and stomach, has undergone some changes from hereditary influence, and the forms and properties of all these parts may have become better adapted to the purposes of an omnivorous animal†.

Predaceous animals seem to require, either a greater quantity of olfactory nerve, or a more extensive surface for it's distribution, than the vegetable eaters. The food of the latter is generally near at hand, and as they have occasion only to select the wholesome from the noxious plants, their olfactory organs, seem to be constructed for the purpose of arresting the effluvia of odorous substances, immediately on their rise. The former are oftentimes under the necessity of discovering the lurking places of their prey at a considerable distance; and are therefore more sensible to the weak impressions of particles widely diffused through the surrounding medium, or slightly adhering to those bodies with which the object of their pursuit may have come into contact.

In

* I have examined the *Incisores*, or fore teeth, in the skull of the antient Egyptian Mummy, in the public library at Cambridge, and found them, with respect to form and magnitude, exactly what Middleton describes them to be:—"Dentes ejus omnes in "maxilla superiore firmiter adhuc inhærentes reperiuntur: quod vero singulare et prodigii "fere loco habendum, anteriores seu incisores, non acuti illi quidem atque ad incidendum "apti, sed perinde ac maxillares, lati plane atque obtusi sunt."

Antiquitat. Middletonianæ, pag. 256.

See also Blumenbach, Institutiones Physiologicæ, Sect. xxvii.

† The Hindoos are perhaps the only people, who abstain entirely from the use of animal food. To them the smell of an European repast is particularly disgusting. It would be curious and instructive to examine the structure of a human stomach, which has never been subject to the stimulus of animal food or fermented liquors.

In the Otter and the Seal, which are, both of them, pertinacious adherents to animal food, the olfactory organs are extremely curious and complex, and (to judge from the extent of their surface) of exquisite sensibility*. As they live altogether upon fish, they may perhaps be able to distinguish odoriferous particles diffused in water, and may enjoy a more delicate perception than is required by such as pursue their prey in the open air.

Tygers, Leopards, Cats, and the whole of the feline tribe are the next in rank, with respect to the intricacy of the olfactory structure: and the acuteness of their smell is in proportion to it. The Cats are obstinately attached to animal food, and particularly fish. It is perhaps owing to their unconquerable dread of water, that their depredations do not extend to that element. They are brought to feed upon vegetables, with great difficulty, excepting only boiled asparagus, which has somewhat of an animal odour†. They delight however in the scent of other plants, such as Valerian, Marum, Nepeta‡, Chenopodium vulvaria, &c. all of which are of a peculiar kind, probably resembling the urine of the animals at certain periods§. This appears to be the more likely, as they are

* These animals are with difficulty killed by bruises or external wounds, unless they are inflicted on the nose; where it is remarkable that a very slight blow is sufficient to dispatch them in an instant. "Quas, dum in rupibus dormiunt," (says Ray, in his Synopsis Animalium Quadrupedum,) "tacitè appropinquantes, et perticis ligneis rostra "transversim ferientes occidunt."

† This smell is rendered more particularly disgusting to the nose by passing the circulation.

‡ The Marum and Nepeta (says the ingenious Dr. Darwin) are particularly delightful to cats; no other brute animals seem delighted with any odours, but those of their food or prey. Botanic Garden, Part II. p. 6.

§ The females have not by any means the same avidity for them, as the males have. Out of fourteen Cats, caught in a trap baited with valerian, only one was a female.

are never observed to swallow any of them, though they will chew them, till they foam at the mouth, and roll in them with infinite delight. Whenever carnivorous animals are gratified by the scent of vegetables, it is probably owing to the resemblance which they bear to some favourite animal odour.

In his wild and undomesticated state, the Dog, like his congeners, the Wolf, Fox, and Jackall, is perfectly carnivorous*; although by the structure of the olfactory bones, he is somewhat allied to the herbivorous tribe. His acute sense of smelling, rapid course, and docile temper, have from the earliest ages recommended him to the notice of mankind. His different talents have been cultivated with infinite care. Strength, fierceness, fleetness, (and even beauty, to the prejudice of his higher qualities,) have oftentimes been the principal objects of consideration. Hence the infinite variety of the species, differing as much in subtilty of smell as in outward form. Compare the grey-hound and lap-dog with the blood-hound and pointer: the one possessing an hereditary excellence, the other an entailed degeneracy, of the olfactory powers. In their native woods, it is reasonable to suppose, that, being all of the same family, they all possess the same, or nearly the same, degree of excellence; nor is it wonderful, that, after strict attention paid to the breed and training of many successive generations, a sense, so apt to vary, should even exceed the natural standard of perfection †.

The

* This must be understood of their diet only. For although one species of grass (gramen caninum) is frequently eaten by them, it is by way of medicine, and operates as an emetic.

† It is by great attention paid to the breeding, that some of them are brought to distinguish one peculiar kind of animal smell, better than another. Hence the various excellencies of the Terrier, Fox-hound, Pointer, Spaniel, &c.

THE observation before made with respect to the nature of the vegetable odours, which attract the notice of Cats, is applicable also to the canine tribe. The *Stapelia hirsuta*, *Phallus impudicus*, and others of the like disgusting scent, are highly grateful to them*. The plants, which they are taught to hunt for and discover by the nose †, have more of the animal, than the vegetable flavour. I believe, they have no discrimination of any other kind; at least, they discover no symptoms either of dislike or satisfaction.

FROM the comparison of these facts, we conclude, that affinity of structure, in the noses of the carnivorous Quadrupeds, is accompanied with similar propensities in the choice of the objects of smell; and that the steadiness of their attachment to animal diet is in proportion to the more or less perfect conformation of the ramified olfactory bones.

SECT. XI.

REMARKS AND OBSERVATIONS ON THE OLFACTORY ORGANS OF THE HERBIVOROUS QUADRUPEDS.

LET us now direct our attention to the Herbivorous Quadrupeds, and institute a similar comparison between the habits of their life, and the structure of their olfactory organs.

IN the simplicity of the turbinated bones, the Hog ‡ bears a strong analogy to the human species. In his wild state, he is perfectly

* A plant of the Stapelia hirsuta, (carrion flower) in full blossom, was placed before a small French dog. He tore the flowers to pieces, and put them out of his mouth with evident disappointment.

† Phallus esculentus, &c. ‡ Vid. Tab. XIV. Fig. 1. G. H.

perfectly herbivorous, and, like the rest of the herbivorous quadrupeds, averse from animal food, though probably in a very inferior degree.

His ethmoidal processes partake of the ramified structure; and by domestication he is rendered omnivorous. This depraved, I had almost said artificial appetite, being propagated like an hereditary taint, the enslaved race seem now to prefer the animal to the vegetable diet. But, notwithstanding his avidity for flesh, it is remarkable, that the vegetables, to which he still gives any preference, are not such as resemble animal odours, but are of the purest vegetable kind*.

As roots form a great part of the natural food of the Hog, he is furnished with a strong muscular snout, callous at the extremity for turning up the soil; and it is worthy of remark, that a large pencil of nerves takes it's course down each side of the nose, and is ramified on this singular though not unparalleled organ†. A sense of a peculiar kind, different both from that of smelling, and the common sense of feeling, is probably resident here; by which the animal can with greater accuracy distinguish the nature, and properties of substances hidden under ground.

Mr. J. Hunter, with his usual penetration, has observed something similar to this in certain parts of the human body, and it probably

* Such as the Bulbocastinum, or Pignut, &c.

† Vid. Collin's Anat. Tab. 54.

" The Mole, as it's habitation is different from that of other animals, so hath it organs " in every respect curiously adapted to that way of life: particularly it's nose made sharp " and slender, but withal tendinous and strong, &c. But what is very remarkable, it " hath such nerves reaching to the end of it's nose and lips, as Ducks have, which pair of " nerves I observed to be much larger in this animal, than any other nerves proceeding " from the brain." Derham's Physico Theology.

probably takes place in more instances than Anatomists are at present aware of *.

THUS we see that the Hog, the nature of whose nose does not admit of any extraordinary degree of accuracy in the faculty of smelling, (as far at least as depends on the structure of the turbinated bones) is provided with auxiliary nerves to supply the deficiency. The branches of the fifth pair sent to that organ in man seem very inadequate to the purpose of discharging a similar office †.

FROM the Hog we shall pass on to an animal so much more obstinately attached to a vegetable diet, that simple domestication has never been able to vitiate his taste. In the HORSE the turbinated bones are more elaborate, by their convolutions, perforations, and septa: and the ethmoidal processes, though of the same character, have fewer and less minute ramifications ‡; the anatomy of the part still corresponding with the appetites and antipathies of the animal. The Horse distinguishes vegetable odours with a considerable degree of accuracy, though his powers in this respect are not so eminent as those of some others, nor his abhorrence of animal effluvia so unconquerable. The Goat, the Sheep, and the

* Vid. Darwin's Zoonomia, Vol. I. Sect. xiv. 9, and Sect. xxxix. 6. where the reader will find much curious and interesting matter on this subject.

† In the Elephant's nose, although the turbinated bones are small, the olfactory nerves are large in proportion to the size of the animal, as appears from the magnitude of the foramina in the ethmoid bone. Vid. Tab. VI. and XV. The surface of the membrane is extended by means of the very numerous ethmoidal cells, and the great extent of the Proboscis. The union of exquisite sensibility, both of smell and touch, in this very extraordinary instrument, renders it probable that, like the snout of the Mole and Swine, it is supplied with auxiliary nerves from the fifth pair.

‡ Vid. Tab. IV. and XIV. Fig. 2. The structure of these bones in the Cow's nose differs not materially from the corresponding bones in the nose of the Horse.

the Deer, whose turbinated bones are more plentifully stored with foramina of a smaller size, and whose ethmoidal processes have no similitude to the ramified bones of the carnivorous tribe*, carefully avoid all plants, whether fresh or dried, that are pernicious to them.

THE Horse does not discriminate so accurately. He will eat many noxious plants, provided they are offered to him in the form of hay, which when fresh he would have carefully rejected. He never crops the tender shoots of yew; but, when they are cut and suffered to wither in the sun, he eats them without hesitation; and is oftentimes irrecoverably poisoned. His antipathy to animal food may be subdued by perseverance, and constraint†; although naturally so averse to it, that he will neither drink water from a bucket, nor eat hay from a rack, to which animal matter, particularly grease, has been applied. He snorts with evident alarm at the smell of blood, or carrion, and reluctantly advances to the place where either of them is deposited.

THE Goat, notwithstanding the proverbial filthiness of his own natural scent, is so scrupulously nice, with respect to all other animal odours, that, if a single grape be only breathed upon, the whole bunch will be greedily devoured, with the exception of that one contaminated grape‡.

THE DEER, from the structure of the turbinated bones, and the ethmoidal processes, claims the highest rank among the herbivorous tribe. His accuracy in the discrimination of vegetable, is equal to his detestation of animal odours. To the latter we must

* Vid. Tab. XIV. Fig. 3.

† A Poulterer in Whitechapel had a horse, who had been first crammed with the entrails of fowls, and afterwards starved till he swallowed them voluntarily; at length he subsisted almost entirely upon them.

‡ To this fact there are many witnesses—The experiment was frequently repeated with invariable success.

must attribute that excess of cruelty, and ferocity, with which a wounded Deer is constantly driven from the herd; qualities altogether repugnant to the nature of the animal.

ADMITTING the foregoing observations to be just, is it not probable that the steadiness of attachment, in the carnivorous Quadrupeds, to animal food, and the adherence of the herbivorous tribe to a vegetable diet, vary according to the different structure of the olfactory bones? And, by marking the gradual progress of these variations, and tracing them step by step, from the most elaborate, to the most simple form, may not the Naturalist be enabled to lay down a regular series, throughout all the different classes and orders: and thus, by repeated observations, establish a kind of systematic arrangement of the olfactory organs of all animals? To form the outline of such a method, let the Seal be placed at the head of the scale carnivorous; and the Deer at the opposite extremity of the herbivorous Quadrupeds; and the intermediate orders according to the degrees of affinity in the shape, situation, and structure, either of the ramified, or turbinated olfactory bones. A more extended scheme might be drawn out upon the following plan*:

SEAL CAT DOG	CARNIVOROUS.	The olfactory bones ramified.
HOG HORSE DEER	HERBIVOROUS.	The olfactory bones turbinated.

THE three orders, which in the above scheme compose the first class, are naturally carnivorous. The SEAL, whom I have placed

* Vid. Tab. XIII. and XIV. where the olfactory bones of the above animals are faithfully represented according to this arrangement.

placed at the head of them, has the anterior and posterior ramifications of the olfactory bones large, numerous, and well defined*: and the lamellated portions are extended in a parallel direction from the anterior to the posterior branches†: the ethmoidal processes are very shallow‡. The animal is perfectly carnivorous, or rather piscivorous; living chiefly, if not entirely, upon fishes.

THE CAT has fewer ramifications of the olfactory bones, than the Seal. The lamellated portions are somewhat convoluted§, and the processes of the ethmoid bone large and numerous||. The Cat is, with difficulty, taught to eat vegetables, even in a domesticated state, and gives the preference to a piscatory diet.

THE DOG has the ramifications of the olfactory bones like those of the Cat, but the lamellated portions are gently bent into a spiral¶. The processes of the ethmoid are larger, and verging toward the turbinated structure⸸. In an unrestrained condition he is carnivorous; though in a state of domestication, he is easily prevailed upon to eat vegetables, and soon becomes indiscriminately edacious; but gives no preference to fish.

As the Dog, in these respects, approaches nearer to the vegetable eaters, than either of the preceding; and as the Hog has greater affinity to the animal eaters, than either of those which follow, I have placed them next to each other in the scale.

THE turbinated bones of the HOG** pronounce him to be of the herbivorous class, but their character is faint and imperfect, their convolutions are slight, and there are no perforations. The ethmoidal

* Tab. XIII. Fig. 1. F. G. † Fig. 1. H. ‡ Fig. 1. D.

§ Fig. 2. D. E. || Fig. 2. F. F. ¶ Fig. 3. F. ⸸ Fig. 3. F. G.

** Vid. Tab. XIV. Fig. 1.

moidal processes are of the carnivorous structure. His natural propensities perfectly accord with this formation. In a wild state he lives upon plants and roots; domestication renders him omnivorous.

In the olfactory bones of the Horse, to whom I have allotted the second place in this division, the vegetable character is decisively marked—The convolutions are complete, and the foramina numerous; but the ethmoidal processes partake of the ramified structure. This animal is herbivorous, both in his wild and domesticated state. At first by constraint, and afterwards by necessity, he has been known to submit to an animal diet.

To the Deer I have assigned the highest rank. The infinity of the perforations, both in the convolutions and septa of the olfactory bones, the turbinated structure and perforations of the ethmoidal processes denote unsullied purity of appetite. I believe the experiment has not been made; but in all likelihood he would fall a victim to his antipathy, rather than be constrained to abandon a vegetable diet.

The ethmoidal processes of the *human nose* are neither ramified like those of the Hog, nor turbinated as the Deer's, but are composed of small cells or sinuses *sui generis*. But, as the *conchæ* resemble the corresponding bones of the vegetable eaters, and there is no part of the human nose which bears any analogy to the same organ in the carnivorous tribe, Man may perhaps with propriety constitute another order of the herbivorous class.

SECT.

SECT. XII.

REMARKS AND OBSERVATIONS ON THE OLFACTORY ORGANS OF BIRDS.

THE true olfactory organs of Birds afford very little scope for observation. The similarity of the turbinated structure leaves but little room for comparison, and the impalpability of their olfactory nerves permits us only to discover, that the carnivorous birds possess them in a larger proportion, than the granivorous. The point, on which the attention more particularly fastens, and to which our enquiries have been chiefly directed, is the relative magnitude, distribution and office of the fifth pair, which we have denominated the *auxiliary* nerves.

IN the granivorous Birds we shewed them to be extremely minute; in birds of prey with hard, strong, and short beaks, of an intermediate size; and in a third kind, of a magnitude which at once declares their importance. This difference, in the size of the auxiliary nerves and the sensibility of the organ, is in exact correspondence with the necessities of the animals. The food of the granivorous tribe is dispersed every where on the surface of the earth: and few odoriferous particles can escape from the hard and polished surfaces of such seeds, as form the greatest part of their nourishment: the Eye, therefore, and not the Nose, is the proper guide. So little do they depend on the latter in their choice, that they may easily be deceived by any artificial representation of their accustomed food, although the scent be altogether different. It is from the inaccuracy of the smell, that they pick up and swallow a great number of small pebbles, which are of use in the digestive process: Providence having wisely ordained, that the very mistakes of the creature should answer a beneficial purpose in the animal œconomy.

THE

The carnivorous tribe, although their eye be keen and penetrating, cannot always avail themselves of it's agency in discovering their food. Their olfactory powers (as we before observed) are extremely subtle, both from the superior magnitude of the auxiliary nerves, and the ample provision made for their distribution. It is with the greatest difficulty that any of this tribe can be habituated to a vegetable diet. The resemblance between them and the carnivorous quadrupeds in this respect, as well as in their faculty of perceiving animal odours at a great distance, is very striking*. There is not, on the other hand, so close an analogy between the granivorous birds, and such of the Quadrupeds as live upon a vegetable diet. Most of them are fond of insects; many will eat boiled or roasted flesh; and some do not refuse pieces of raw meat, or even of carrion—An additional proof of defective sensibility in the organ of smell.

The food of the omnivorous Birds is frequently placed beneath the surfaces of bogs, under the gravel and sand of rivulets, or in the mud deposited by stagnant water. In such situations, vision is impracticable, nor can the nose act, at least in the usual way. Here then the auxiliary nerves are not only important but essential to subsistence. They are probably the organs of a distinct, or rather a compounded sense, discharging at once the various offices of smell, taste, and touch. If, as we conjecture, they are distributed in common with the true olfactory nerves on the membrane, there may possibly be a sympathy between them, and each may excite the other into action, though the original impression be made only on one. The peculiar manner in which Ducks apply their

* From their faculty of discovering dead bodies at a great distance, it is, that Ravens and Owls were in all ages accounted ill omens. Derham even goes so far as to suppose, that the Ravens, by their accurate smell, may discover the cadaverous scent, "emitted "from those diseased bodies, which have in them the principles of a speedy death."
Vid. Derham's Physico Theology.

their beaks in search of food (by Derham called *quaffering**) resembles the delicate and tremulous handling of blind persons, to whom the loss of vision is, in some degree, compensated by refinement of the sense of touch.

THE external nostrils of this class are relatively small, and defended by *vibrisci* from the introduction of insects, dust, or other minute substances, which might irritate and injure the organs; these hairs too, are most conspicuous in birds of prey.

THE Turkey has an extraordinary appendix, which seems to be placed as a guard to the nostrils. In the female it is of a smaller size, and ornamented with feathers†.

* Attention to the peculiar habits or gestures of animals, might lead to the discovery of many curious anatomical facts.

† Tab. VII. Fig. 1. D.

In the male bird this strange appendix is of considerable size, and there is also a large quantity of the same kind of substance placed under the throat; the blood vessels of which, as well as of the nasal appendix, are plentifully ramified throughout the whole mass. The action of these vessels is so completely regulated by the operations of the nervous system, that, when the animal is under the influence of certain passions, such as fear, anger, lust, &c. the parts exhibit the most beautiful phenomena of colours that can be conceived. The changes from a bright crimson, to all the different shades of pink, purple, blue, and violet, take place either suddenly or slowly, according to the degrees of irritation, provocation, &c. to which the creature is exposed. But, when the bird is inactive, and his mind at rest, the vessels of these parts are likewise quiescent, and they remain perfectly white. The effects are evidently analogous to blushing in the human subject.

SECT. XIII.

REMARKS AND OBSERVATIONS ON THE OLFACTORY ORGANS OF FISHES.

IN examining the olfactory organs of fishes, our attention was arrested by the very ample size of the nerves, which pass out of the skull in firm and undivided cords. In some kinds they were found to ramify on a membrane of very considerable extent, and it was concluded that great acuteness of perception arose from the magnitude of the sensitive surface. In others an accumulation of medullary matter in the shape of a small round ball, situated near the nostril, was thought to compensate for deficiency of that surface, by increasing the sensibility of the nerve itself.

As the habits and manners of this class are, for the most part, placed beyond the reach of our observation, by the element which they inhabit, we cannot pronounce decisively on the relative acuteness of this organ, or point out with precision the correspondence between the structure of it, and the necessities of the animal. We may however safely conjecture, that each particular mode of conformation in them, as well as in the land animals, is adapted to the search and discovery of a particular species of nourishment. This supposition derives considerable weight from the analogy, which obtains in the distribution of the fifth pair of nerves, which we have described as auxiliary to the first pair in the Hog, the Mole, in many of the omnivorous birds, and last of all in the Skate.

AN animal, whose olfactory organs are acted upon by aëriform fluids only, must conceive very imperfectly what is the nature of this sense in the inhabitants of a different element. If water strongly impregnated with odorous particles be applied in substance to

to the nostril, there is either no sensation at all, or one exactly similar to common feeling; such as will be excited by the action of acrid substances upon excoriated parts. If the same water be applied to the tongue, the gustatory nerves immediately take cognizance of it. The very same particles which in the form of vapour are perceptible by the nose, do as a liquid affect the palate only. Is the sensation of smell in fishes then analogous to that of man? or is it only a more subtle and exquisite species of taste, capable of detecting and discriminating the slightest impregnation?

SECT. XIV.

REMARKS AND OBSERVATIONS ON THE OLFACTORY ORGANS OF ANIMALS IN GENERAL.

IN taking a view of the comparative anatomy of the Nose, in the classes, *Mammalia*, *Aves*, *Pisces*, and *Amphibia*, we are struck with the general analogy, observable in the composition and adjustment of the olfactory organs of each. And even, where they fail with respect to a close conformity, we can in most instances discover the necessity of the deviation, by examining their usual places of residence, and scrutinizing the manners of the inhabitants. The external nostrils in all animals are in the neighbourhood of the mouth. In the generality of Quadrupeds they are situated near the extremity of the snout, just above the upper lip, as if to perform the office of sentinel at the principal entrance.

IN birds they are placed at some distance from the end of the beak. Had they been at the extremity, the inconvenience, that would have arisen from such a situation, is evident.

In Fishes, they are situated either on the superior convex side of the head, as in the Pike, Cod, Haddock, &c. whose mouth is placed in front for catching their prey in midwater; or on the inferior and flat side, as in the Skate and Angel-fish, in which the jaws open beneath, for the purpose of laying hold of the shell fish, which inhabit the sands at the bottom.

In Man and in Quadrupeds, the surrounding bones are hollowed into cells or sinuses, the deficiency of which in the carnivorous birds is supplied by the sponginess of the bones in the vicinity of the nose. But the fishes, who neither require the nostrils to be moistened with mucus, nor cells for the passage of air, or propagation of sound, have nothing substituted in lieu of these cavities. In man and in quadrupeds, who have wide nostrils, the olfactory nerves are spread upon a membrane supported by bony plates, to obviate any derangement from sudden gusts of air. In birds, which have small close external openings to the nose, defended by vibrisci, or by feathers, the turbinated structure is either cartilaginous or membranous. But in fishes, as the water, which they breathe, passes and repasses without any considerable variation of force, the whole structure is membranous, being furnished only with a cartilaginous rib or ligamentous border to keep the membrane duly stretched.

In Man, Quadrupeds, and Birds, the olfactory membrane is of a pale colour, but in such fishes, as I have examined, it is black, like the choroid coat of the eye. The Turtle has cartilages resembling the turbinated bones of the herbivorous quadrupeds, which he resembles also in being a vegetable eater. The colour of the olfactory membrane is black as it is in fishes*.

* Whether the same remark holds good with respect to the rest of the Amphibia, the Author has had no opportunity of observing.

EXPLANATION

EXPLANATION OF THE TABLES.

TAB. I.

A Front view of the Cranium of the *Phoca*, or Seal, shewing the structure of the bones in the fore part of the nose, where it resembles that section of the cerebellum, called *Arbor Vitæ*.

AA. Contour of the cranium.
BB. Superior maxillary bones.
CC. Two large holes, through which pass the superior maxillary nerves.
DD. Alveoli from which the teeth have fallen.
EE. The anterior portion of the bones, from which an infinite number of plates or lamellæ of the greatest conceivable tenuity are sent off*, and form a structure in the posterior part similar to that in front. The principal trunk E is attached to the arch of the maxillary bone a little above the dotted line; which attachment is continued by means of a bony rib, as far as the convex surface of the orbit of the eye; none of the branches, or plates, having any other connexion with the surrounding cavity.
F. The Septum Nasi.

* See a profile of this part in Tab. XIII. Fig. 1.

TAB. II.

THIS table represents the section of a Dog's nose. The Septum Nasi is removed, and we have a side view not only of the ramified bones, but also of one half of the lamellated processes of the ethmoid bone* covered with the olfactory membrane.

A. A longitudinal section of the skull.
B. The Frontal Sinus.
C. Posterior processes of the ethmoid bone.
D. The cribriform process.
E. The anterior portion of the ramified olfactory bones, covered with their proper membrane—at which part they are similar to those of the Seal†; but the thin plates, which originate here, do not pass on to be connected with similar ramifications backwards, but are confounded with the processes of the ethmoid bone C, which now begin to resemble the turbinated bones of the herbivorous tribe.
F. One of the ethmoidal processes remarkably distinct and separate from the rest.
G. The Dentes Incisores.
H. The Molares.
I. The tip of the nose by which the preparation is suspended.

In the whole of this preparation the membrane was preserved and the blood vessels injected with red wax.

* See a profile of the Fox's nose denuded of it's membrane. Tab. XIII. Fig. 3.

† Vid. Tab. I.

TAB.

TAB. III.

A TRANSVERSE Section of the turbinated olfactory bones, &c. of the nose of a Sheep. The olfactory membrane is preserved both upon the *Septum*, and the turbinated bones: the regular and beautiful distribution of the arteries upon this membrane is here inimitably well represented. The right side of the nose has been removed to shew the *septum* and it's blood vessels as at C.

A and B. The convolutions of the inferior turbinated bone on the left side. The arteries upon these bones run parallel to each other, and are marked in the engraving by black lines. When the membrane is separated by boiling or maceration, the bones are found to be every where perforated by a great number of small holes, through which the blood vessels and nerves pass from one side of the bony convolutions to the other, as in the nose of the Deer. (Tab. xiv. 3)

C. The Septum Nasi, with it's blood vessels, &c.

D. Part of the roof of the mouth.

E. The teeth.

F. Larva of the *Œstrus Nasalis* of Linnæus, a great number of which were found not only in the convolutions of the turbinated bones, but also in the antrum or cavity in the upper jaw at G; and likewise in the frontal sinus.

TAB. IV.

THE inferior turbinated bone on the right side of the horse's nose.

A. B. A bony plate with a smooth flat surface and irregular indentations at the edge, by which it was joined to the superior maxillary bone.

C. The upper part of the bone with it's numerous perforations.

D. The inferior portion of it, with it's external part broken off, to shew the thin plates of bone, by which the cavity is intersected.

EEEE. The bony partitions or *Septa*, as they appear when the perforated shell-like covering hath been removed.

F. A portion of the superior division of this bone cut away, that the beginning of the spiral convolutions contained in it may be seen.

TAB. V.

THIS plate represents a transverse section of the Proboscis of an Elephant, which had been previously divided according to it's length.

AA. The two cavities, through which the animal respires, divided longitudinally. They are lined internally with a fine polished membrane. The surface of this membrane is lubricated by a viscous fluid, which answers the same purposes as in the nostrils of other animals.

B. The septum, by which the two cavities are separated throughout the whole length of the trunk.

CC. Distinct fasciculi of muscular fibres: the direction of which in the external layer is longitudinal, and in the internal from the circumference towards the centre. By the separate or combined action of these muscular fasciculi the motions of this extraordinary machine are infinitely varied in every possible direction, so that it can at once perform the office of a nose, a hand, an instrument of labour, and a weapon of defence.

DD. The surface of the longitudinal section.

EE. Two arteries divided in the transverse section of the Proboscis: they are situated near the middle of it's substance, and run the whole length of the trunk: a great number, smaller than these, run in the same direction.

TAB. VI.

THIS table, in which part of the occipital and temporal bones have been broken off from the back part of the cranium of an Elephant, shews the internal surface of the cribriform process of the ethmoid bone, &c.

AAA. Outline of the cranium, the external parts of which are not shaded.

B. A small rising or process of the ethmoid bone, which in the human subject forms the *Crista Galli*.

CC. The cribriform process of the same bone, with it's large and numerous perforations for the passage of the olfactory nerves, very distinctly represented.

DD. Holes, through which the optic nerves pass to the eye—they are in proportion to the size of the eye, which is extremely small, when compared with the general bulk of the animal.

E. Cells which have communication with the nose.

TAB. VII.

FIG. 1.

THE head of a Turkey, in which a perpendicular section of the superior part of the nose has been made through the bone, above the basis of the beak, which brings into view the spiral form of the turbinated cartilages, &c.

A. The frontal bone, in which there is no cellular structure.
B. The Septum Nasi.
C. A transverse section of the spiral convolutions of the conchæ, or superior turbinated cartilage, over which the olfactory membrane was spread.
D. A pendulous substance composed of skin and cellular membrane, ornamented with feathers, which the animal can either elongate or retract, at pleasure.
E. Two very small nerves running on the sides of the septum to the upper mandible.

FIG. 2.

THE head of a Buzzard, prepared in the same manner, to shew the corresponding parts.

A. The turbinated cartilages.
BB. Auxiliary nerves, much larger than in Fig. 1.
C. The spongy texture of the bones, which surround the organ of smell.
D. The left nostril.

FIG. 3.

REPRESENTS a portion of the superior, and the whole of the inferior turbinated cartilages, on the right side of the Turkey's nose.

A. Section of the superior turbinated cartilage, where it was divided at C. Fig. 1.
B. The inferior turbinated cartilage, upon which the small branches of the nerve were beautifully ramified, and visible without the assistance of a microscope.

TAB. VIII.

Fig. 1.

The Head of a Duck. The eyes, the muscular parts of the head, and the external covering of the bill have been dissected off, that the following parts might be brought into view.

A. The socket, from which the eye hath been removed.

B. The optic nerve.

CC. The superior branch of the auxiliary nerve, which makes it's exit from the cranium, a little behind the optic nerve, and bends it's course over the back part of the orbit, till it reaches the side of the nose at D, where it passes through a hole, (E. Fig. 2.) and running along by the side of the cavernous bones of the nose, it bends downwards at C, to get behind the external nostrils at E, where it again separates into two branches, which run close by the side of each other, towards the extremity of the bill, and are then beautifully ramified and dispersed upon it.

D. The bone removed, to shew the naked nerve as it runs along the side of the nose.

E. The division of the superior branch, immediately under the external openings of the nostril.

F. A horny plate, like the nail of the human finger, which it likewise resembles in it's office of guarding the tender extremities of the nerves from external injuries.

G. The left side of the horny plate removed, to discover the fine extremities of the nerves, which lie under it.

HH. The inferior branch of the auxiliary nerve, which makes it's exit from the skull, at the lower part of the orbit, (Fig. 2. C.) and is destined to supply the side and inferior edge of the

the upper mandible (HH. Fig. 2); at which part the numerous ramifications of this branch, as they appear upon the spongy substance of the beak, are distinctly seen.

K. A considerable branch, which is detached from the second branch, before it quits the orbit of the eye, and is spent upon the lower mandible.

L. The external opening of the ear.

FIG. 2.

REPRESENTS a front view of the above parts.

A. The brain—part of the skull having been removed.

BB. The two optic nerves.

CC. The exit of the inferior branches of the auxiliary nerve, from the cavity of the cranium.

D. The bone on the left side removed, that the main trunks of the superior and inferior branches may appear.

E. The bone preserved on the right side, where it covers the nerves in their passage from the orbit of the eye.

FF. The superior nerves, at their division under the nostrils—that part of the bone (E Fig. 1.) which covered them having been removed.

GG. The distribution of them upon the point of the beak—the horny portion being entirely taken off.

HH. The ramifications of the inferior nerves upon the sides of the beak.

I. Cellular structure of the bone, which supplies the place of our ethmoid bone. Upon this and upon two small turbinated cartilages, the pulpy branches of the olfactory nerves are distributed, bearing no proportion either in size or extent to the large nerves which we are now describing.

FIG.

FIG. 3.

THE upper part of the cranium taken off, and the brain pressed on one side, to discover the origin, and extraordinary magnitude of the auxiliary or fifth pair of nerves.

AA. The eyes.

B. The brain drawn towards the left side, to expose the part where the auxiliary nerve takes it's rise at C.

D. The superior, and

E. The inferior branch of that nerve, where it passes under a very strong process of the *dura mater*, which is here removed. The upper branch takes it's course obliquely upwards and inwards; the lower one rather downwards and forwards; the latter gets into the orbit at C. Fig. 2, and the former at C. Fig. 1.

F. The seventh pair, or auditory nerves, going to the ear.

G. The Cerebellum.

FIG. 4.

THE internal basis of the skull, as it appears when the brain and membranes are removed.

TAB. IX.

Fig. 1.

The brain of the Pike covered by it's membranes, which were transparent, and beautifully tinged with a greenish golden hue, not unlike the colour of the external skin of his head.

A. The anterior, and
B. The posterior lobes of the brain.
C. The spinal marrow.
D. The cerebellum.

Fig. 2.

Represents the head of a Pike, the upper part of the skull being removed to shew the cerebrum and cerebellum, the course of the olfactory nerves, &c.

A. The spinal marrow.
B. The cerebellum.
C. The left gill exposed.
DD. The posterior lobes of the brain.
EE. The anterior lobes.
FF. The olfactory nerves at their exit from the brain—they run parallel for about half their length, and then diverge from each other and pursue a separate course towards the two nostrils L. M.
GG. The optic nerves.
HH. The fifth pair of nerves, several branches of which of considerable magnitude pass into the sclerotic coat of the eye at *; other branches of it supply the muscles of the eye and parts adjacent.
II. The transparent cornea of the eyes on each side.

KK. The

KK. The olfactory nerves, beautifully ramifying, before they pass into duplicatures of the membrane, upon which they are to be distributed, to constitute the organ of smell.

L. The radiated duplicatures of this membrane, uniting at the centre, and diverging from thence towards the circumference, where they are connected by a ligamentous circular band—the whole being no very faint resemblance to the nave, spokes, and felloe of a carriage wheel.

M. The nostril on the right side, undissected, where there is a membrane continued from the external skin that contracts the circumference, and by a transverse process forms a membranous bridge, which divides the opening into two, and gives it the appearance of a double nostril. The use of this bridge is to reduce the size of the external orifice, so as to prevent any hard substances floating in the water, from rushing into the cavity, and injuring the tender nervous structure of the olfactory organ.

NN. The external orifices of two large mucus ducts. These ducts were discovered in the fishes by Monro, and are described and figured by him in his ingenious work on the anatomy of that class of animals. They afford a constant supply of a glairy fluid, which is the cause of the wonderful lubricity of their external skin.

O. The end of the snout.

TAB. X.

This table represents the brain and nerves of a Skate-fish; in which the extraordinary magnitude of the olfactory nerves cannot escape the notice of the most superficial observer. Monro* has observed that these nerves are much larger, where they enter the nose, than where they rise from the brain, which he attributes to the thickness of the coats they receive in their course. They are afterwards divided into fine branches, and distributed upon the olfactory membrane, the very numerous and curious foldings of which are delineated in the next table at D.

A. The point of the snout.
B. The eye-balls.
C. Two large holes, opening into the mouth, through which the water constantly passes.
1. A cavity in the fore part of the cranium, which is filled with a transparent jelly.
2, 2. The olfactory nerves at their origin.
3, 3. The anterior lobes of the brain.
4. A middle lobe.
5, 5. The optic nerves.
6, 7, 8. Nerves resembling the third, fourth, and sixth pair.
9, 9. The posterior lobes of the brain.
10. The cerebellum.
11, 11. †The fifth pair of nerves, very large.
12, 12. The seventh pair at it's entrance into the ear.
13. The cavity of the ear laid open.
14. The corpora olivaria.

* Vid. Monro's Struct. and Phys. of Fishes. Tab. xxxiv.

† See the branches in Tab. II. passing to the nose, mouth, &c.

TAB. XI.

THE under side of the head of the Skate fish.

An incision was made between the lower jaw and the nose, and the parts dissected on the left side, to shew the branches of the fifth pair of nerves going to the nose, and to both the jaws.

A. The extremity of the snout.

B. One of the small hemispheroidal bones, which give rise to the sharp spines; the mucilaginous substance which surrounded it being removed, to shew it's form.

C. Ramifications of the superior maxillary branch of the fifth pair, seen through the transparent substance, in which they are immersed.

D. The organ of smell, in which the duplicatures of the olfactory membrane and their interstices are represented.

E. A cartilaginous bridge, separating the two pectinated divisions of this membrane from each other, and giving to the whole the appearance of a small-toothed comb.

F. The part, from which an elastic flap, that covered a considerable share of the external opening, hath been removed.

G. Nasal branches of the fifth pair, in their passage to the nose.

H. That branch of the fifth pair, which is distributed upon the snout and parts adjacent, as expressed at C.

I. A large branch of the same nerve, making a turn round the angle of the mouth, to be afterwards spent upon the lower jaw.

K. The mouth. The teeth are very numerous, closely connected with each other, having a quadrangular smooth surface, which bears some similitude to a tessellated pavement, and are extremely well adapted to the purpose of breaking the small shell fish, upon which the animal preys.

TAB. XII.

PART of the basis of a Sheep's skull, prepared so as to shew the plexus of vessels called *Rete Mirabile* *.

A. A cavity, on each side of which are situated the small serpentine branches of the carotid arteries, which form the plexus.

BB. The infinite ramifications of these vessels, which from their appearance and first discoverer, have been called *Rete Mirabile Galeni*. The plate of bone that covered them has been entirely removed on the right side, and partially left on the other at F.

C. The division of the carotid artery into three branches, at it's entrance into the bone.

D. The main trunk of the carotid artery.

EE. The reunion of all the capillary branches, before their entrance into the brain.

F. Part of the bone which covered the plexus remaining in situ.

* See a Representation of this Plexus, in the fœtus of a Calf, in Monro's Observations on the Structure and Functions of the Nervous System.

TAB. XIII.

FIG. 1. 2. 3.

REPRESENT the bony structure of the olfactory organs of the Seal, the Cat, and the Fox; the *Septum Nasi* in each specimen having been previously removed. In the first specimen the ramified form is double: in the two last it takes place only in the front—and the posterior structure resembles in some degree the turbinated bones of the herbivorous Quadrupeds, but in the Cat is more complex and more nearly allied to the carnivorous, than in the Fox or Dog.

FIG. 1.

A LONGITUDINAL Section of the Cranium of a Seal, in which the ramified structure of the olfactory bones is represented in profile*.

A. The internal cavity of the skull.
B. That process of the occipital bone, which forms a part of the *Tentorium*, and to which the *dura mater* is attached.
C. The ethmoid bone.
D. Shallow processes of that bone, communicating with the upper portion of the ramified olfactory bones at E. The whole of this bone is extremely thin, being compressed into a narrow compass by the very large orbit of the eye, which is situated on it's external side.
F. The anterior, and
G. The posterior surfaces of the ramified olfactory bones.
H. The thin bony plates, proceeding from the above ramifications.

FIG.

* For a front view of the same, see Tab. I.

FIG. 2.

A SIMILAR section of the skull of a Cat.

A. The cavity of the cranium.
B. The process of the occipital bone, for the attachment of the *dura mater*.
C. The small frontal sinus; which in the Fox and Dog is still smaller in proportion. (Tab. II. B.) In the Seal there is none at all.
D. The ramified portion of the olfactory bones, analogous to those of the Seal at F, (Fig. 1.) and those of the Fox at D, (Fig. 3.)
E. Laminæ or plates, issuing from these ramifications, as in the Seal; but which are somewhat bent and convoluted.
FF. Numerous processes of the ethmoid bone, being of a mixed (or intermediate) structure, between the ramified bones of the carnivorous, and the turbinated bones of the granivorous Quadrupeds.
G. The cribriform process, with it's perforations for the passage of the olfactory nerves.

FIG. 3.

SECTION of a Fox's skull.

A. The cavity of the cranium.
B. The process for the attachment of the *dura mater*.
C. The cribriform process of the ethmoid bone, with it's perforations.
D. The ramifications of the olfactory bones.
E. Their laminated processes, bent into a spiral.
F. Processes of the ethmoid bone.
G. One of these processes, more nearly resembling the turbinated bones of the herbivorous Quadrupeds.

TAB.

TAB. XIV.

FIG. 1. 2 3.

IN this table the bony structure of the olfactory organs in the herbivorous Quadrupeds, is explained. The bones of the Hog's nose are placed first, as being the most analogous to the carnivorous form. Fig. 2. exhibits the olfactory bones of the Horse, as being more remote, and Fig. 3. the same bones in the Deer, which bear the most distant resemblance to those of the carnivorous tribe. A similar gradation of structure may here be traced in the herbivorous, to that which was represented in the foregoing Table in the carnivorous Quadrupeds.

FIG. 1.

A SECTION of the skull of a Hog, shewing the olfactory bones of that animal on the left side.

A. The cavity of the cranium.
B. The occipital bone, of extraordinary thickness and strength.
C. The styloid process, uncommonly long.
D. *Os petrosum.*
EE. The frontal sinus; part of the septum which divides the cavity being left.
F. The ethmoid bone, with it's numerous ramifications.
G. The superior turbinated bone, destitute of convolutions and perforations.
H. The inferior turbinated bone, without perforations, and simply convoluted within.

FIG. 2.

THE skull of a Horse, longitudinally divided.

A. The cavity of the cranium.
B. The frontal sinus.
C. The ethmoid bone and it's processes*.
E. The superior, and
F. The inferior turbinated bones, with their numerous perforations: within they are beautifully convoluted, and intersected by bony septa; for a representation of which, see Tab. IV.

FIG. 3.

A LONGITUDINAL section of the skull of a Deer.

A. The cavity of the cranium.
B. Part of the horn.
C. The ethmoid bone and it's processes, all of them elegantly perforated, as are the turbinated bones—the whole forming a very beautiful lace-work.
D. The superior, and
E. The inferior turbinated bones. Within they are convoluted, and the convolutions intersected by septa, as in the Horse, the septa being perforated in like manner as the bones themselves.

* The Letter D is omitted by mistake in the engraving, but ought to be placed below the frontal sinus B. in a situation similar to that referred to, by letter F. Fig. 1.

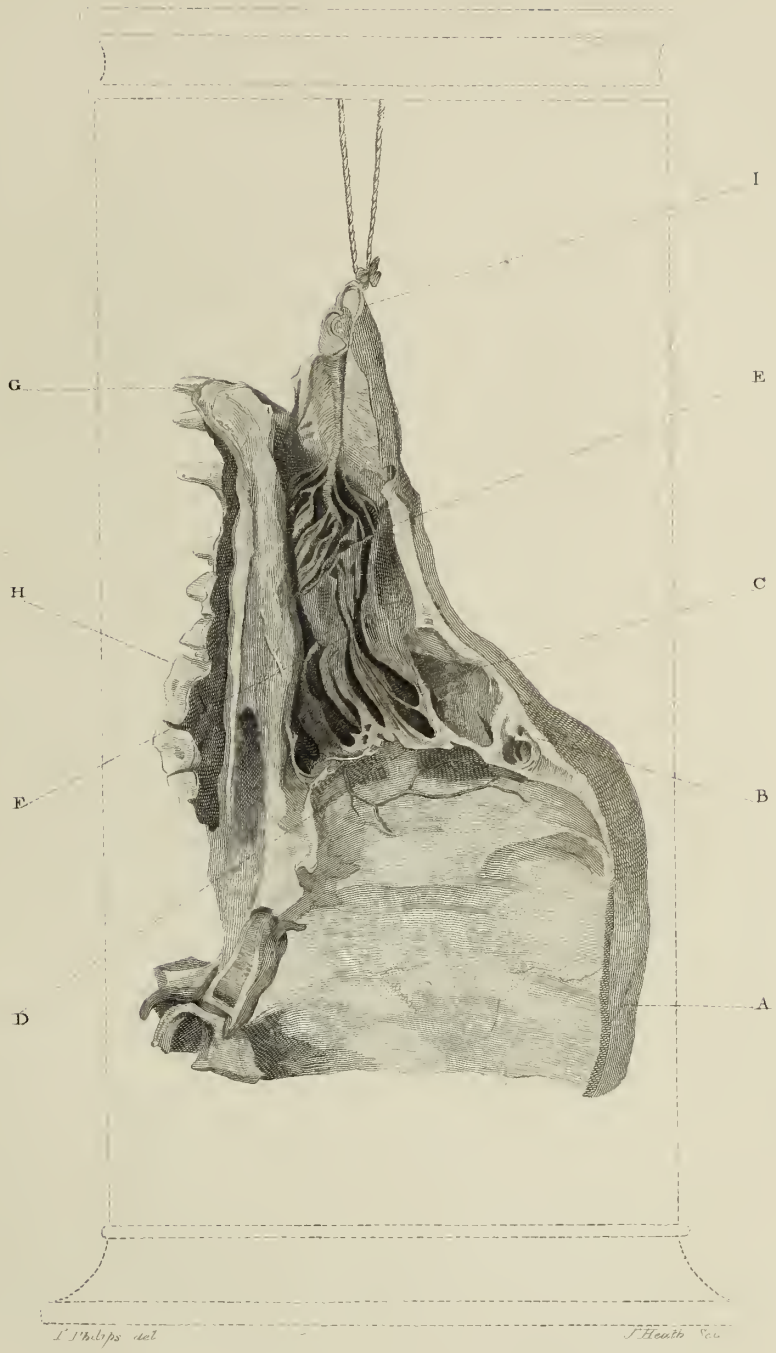
TAB. XV.

THE Skull of an Elephant, part of the bone having been cut away, to shew the large cells in all the bones surrounding the nose.

A. A rough protuberance, to which the proboscis was attached.
BB. Cells and cavities opening into the nose.
C. C. C. C. Shews the internal structure of these cavities, in the frontal bone, the bones of the upper jaw, &c.
D. A large process of the upper jaw, which is protruded forwards to a considerable length, and forms a deep hollow groove in the middle for the convenient lodgement of the proboscis.
E. A section of the socket, in which the large tusk was lodged.
F. One of the grinders of the right side.
G. The *Septum Nasi*.

F
A
A
E
E
B
B
C
C
D
D

TAB. II.



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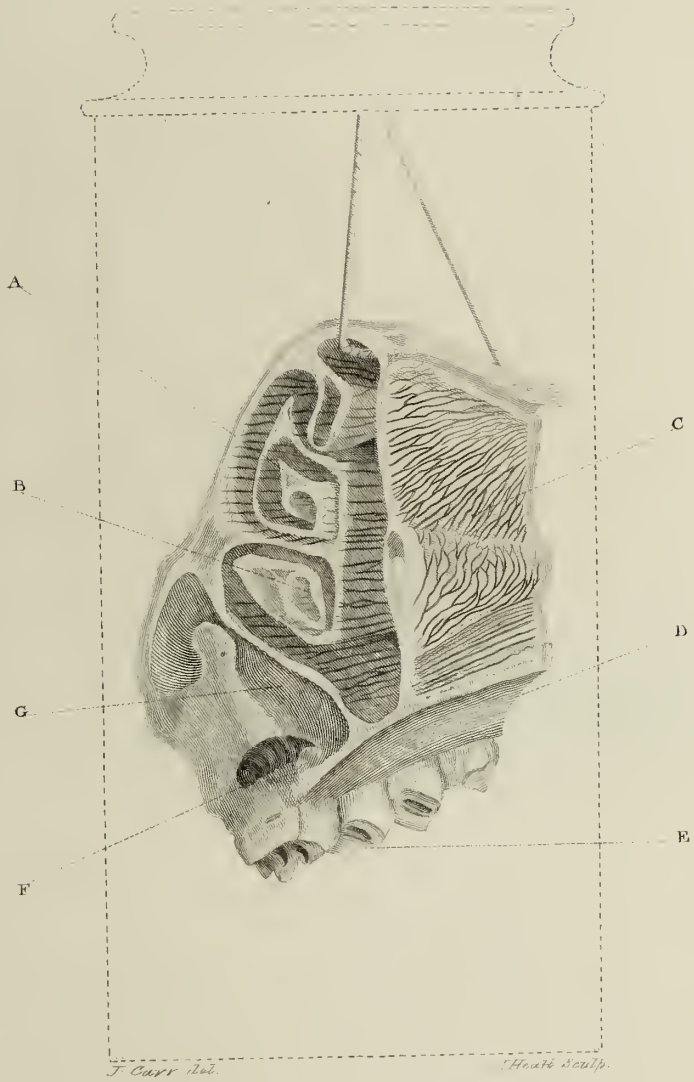

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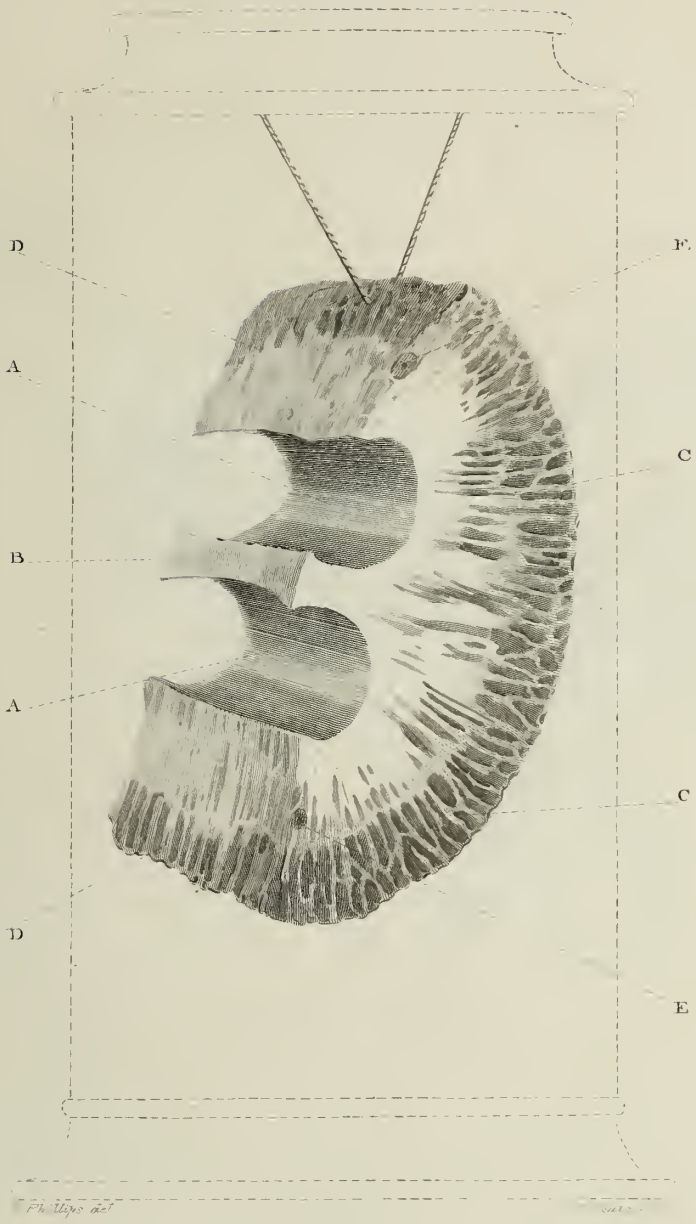

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TAB. 6.

TAB. 7.

TAB. 8.

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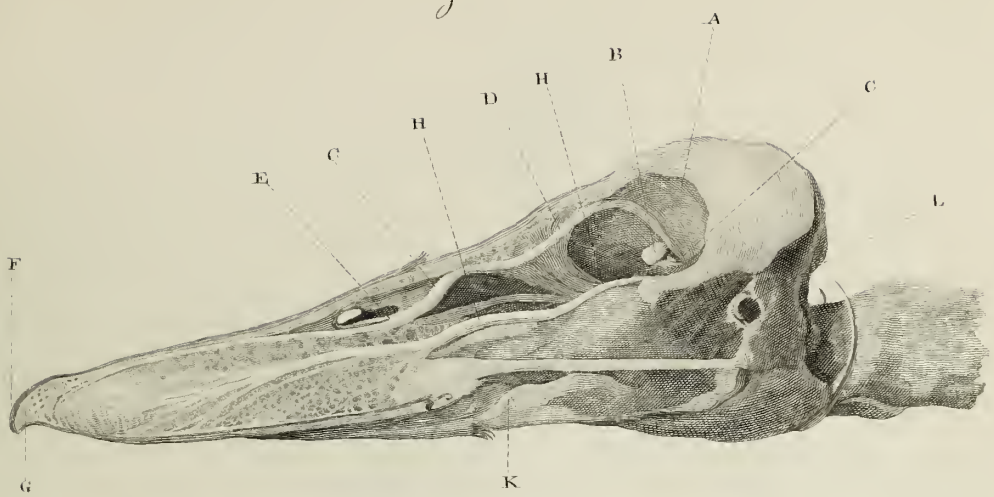
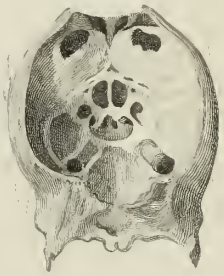


Fig. 2.

Fig. 3.

Fig. 4.



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TAB. 9.

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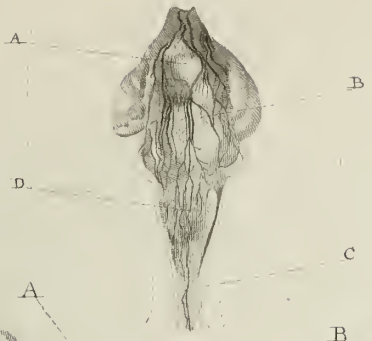

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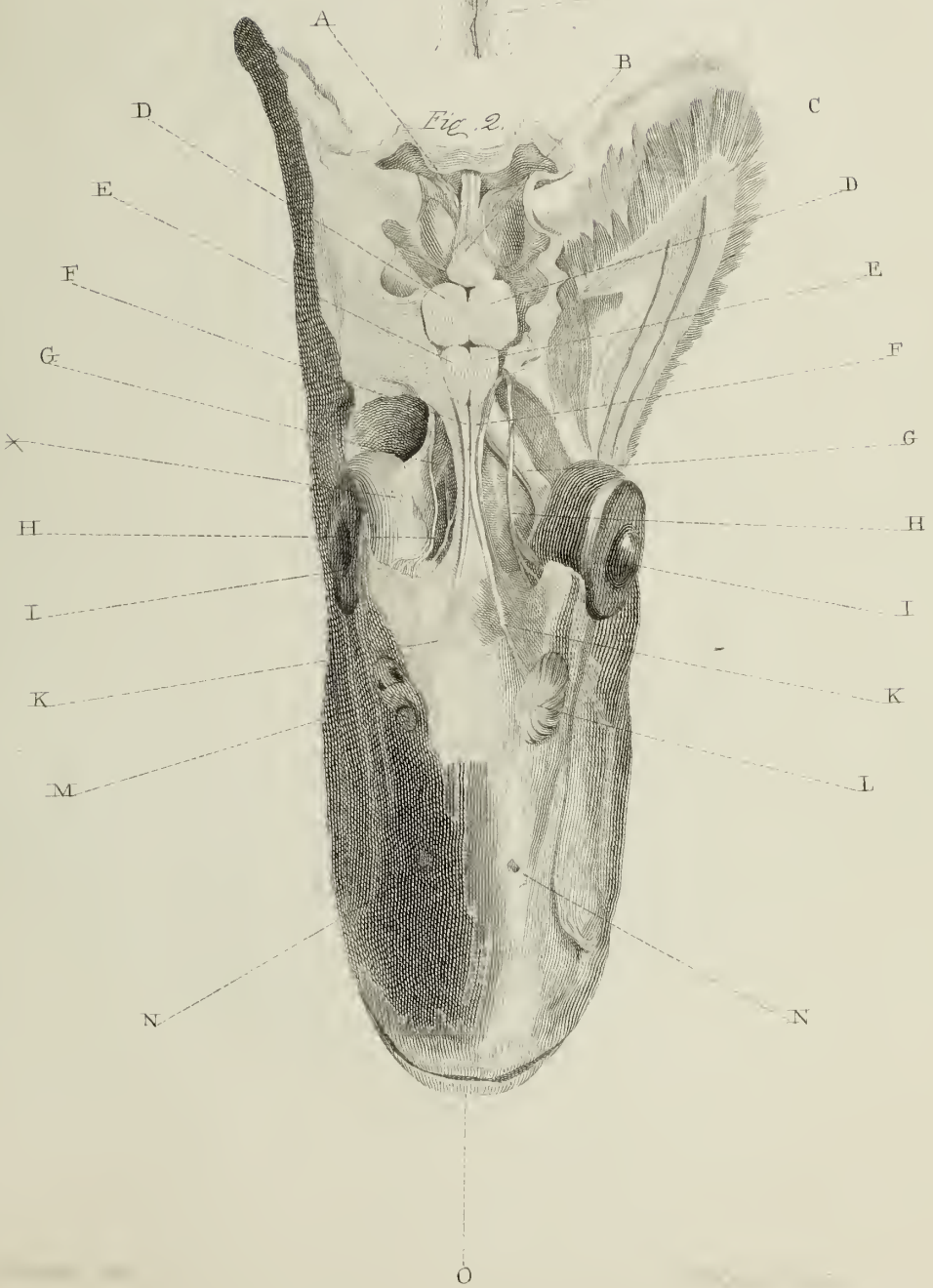

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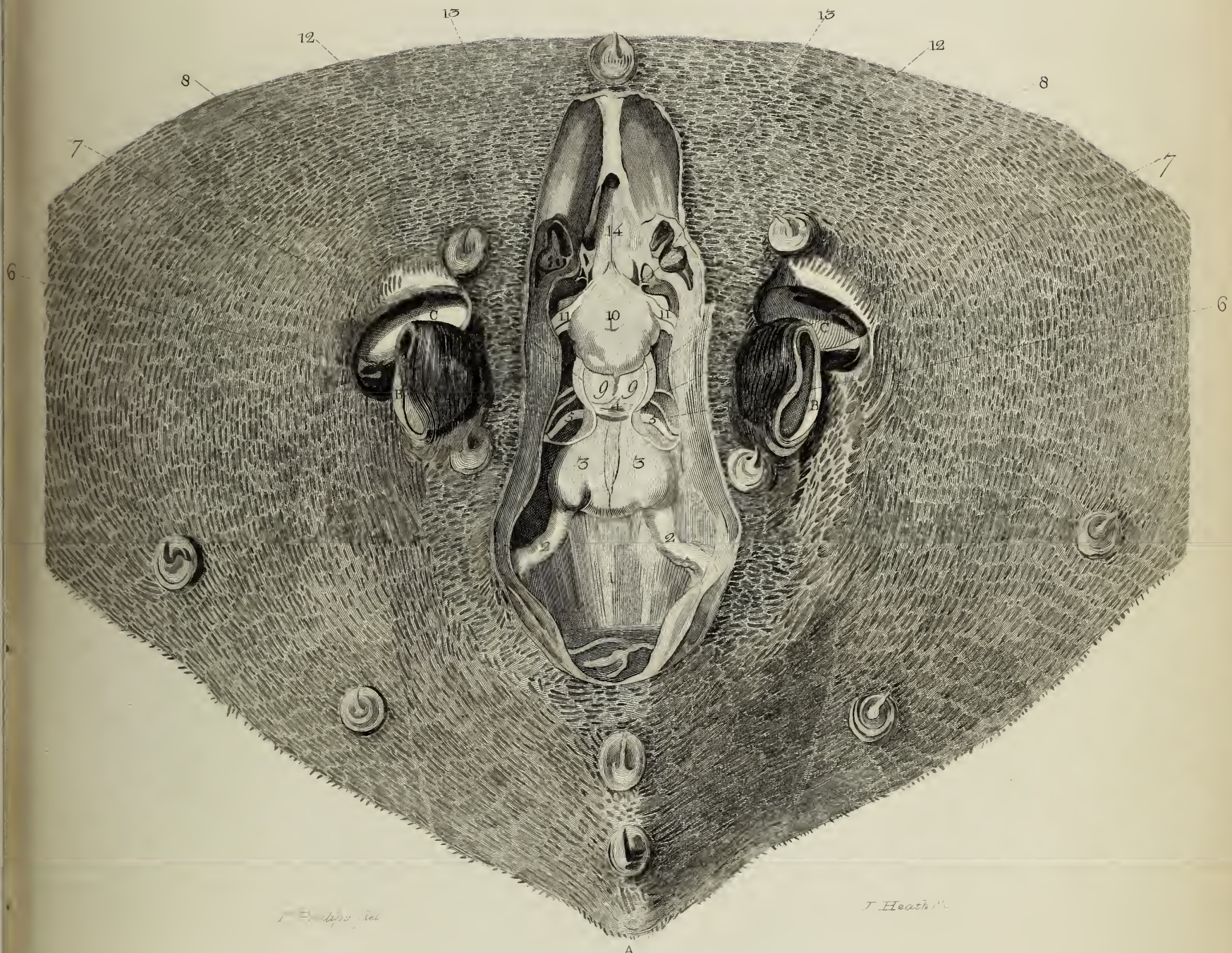

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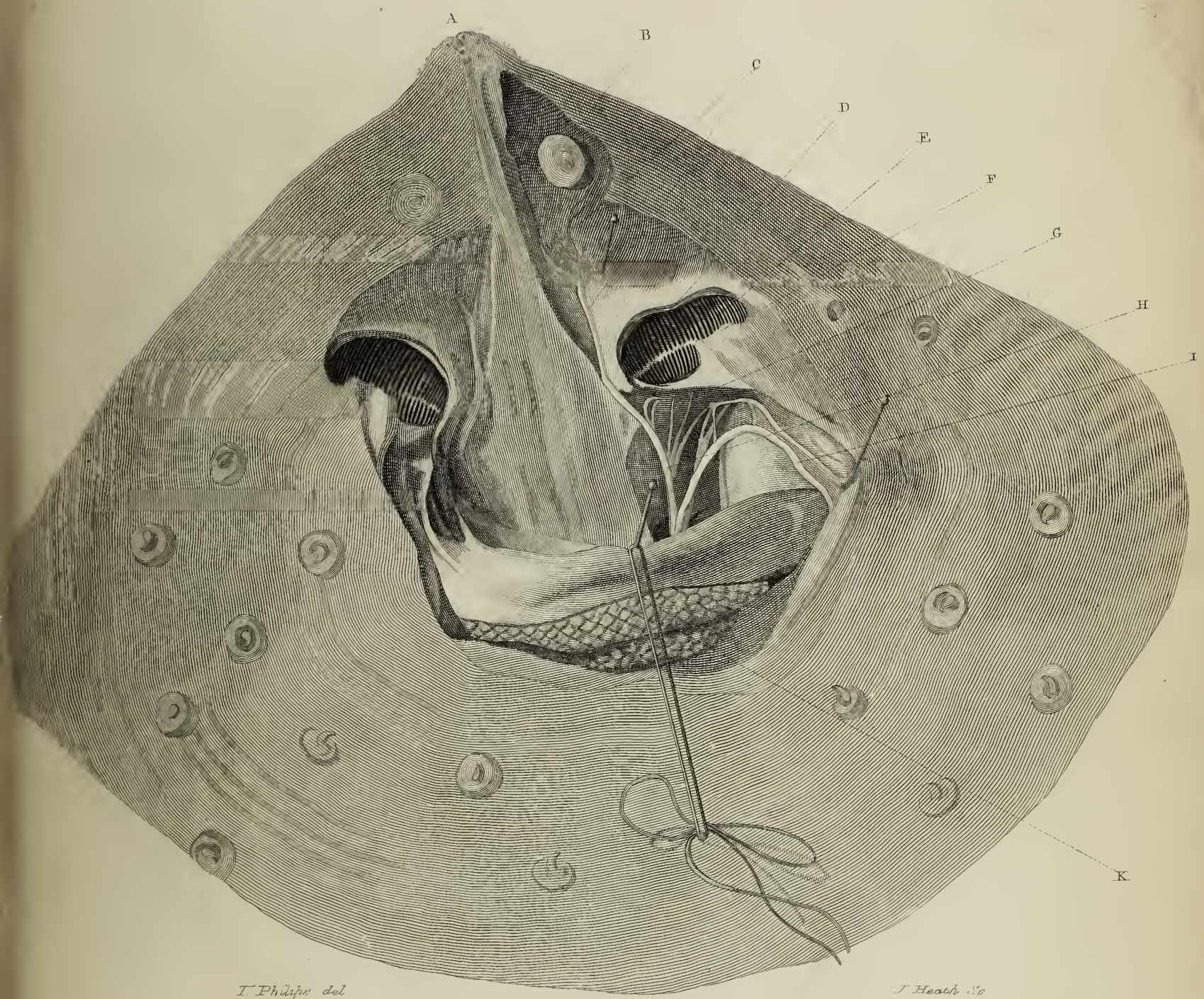

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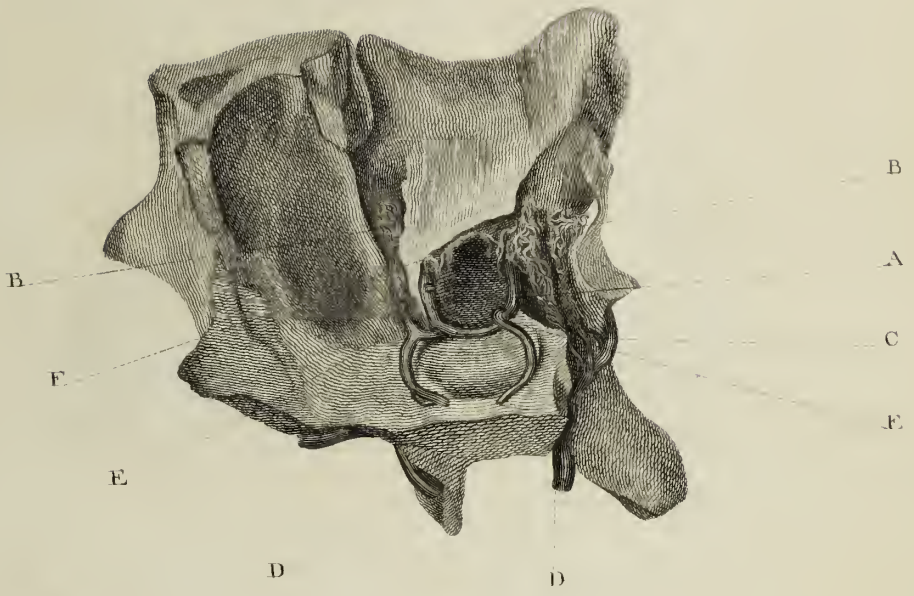

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TAB. 13.

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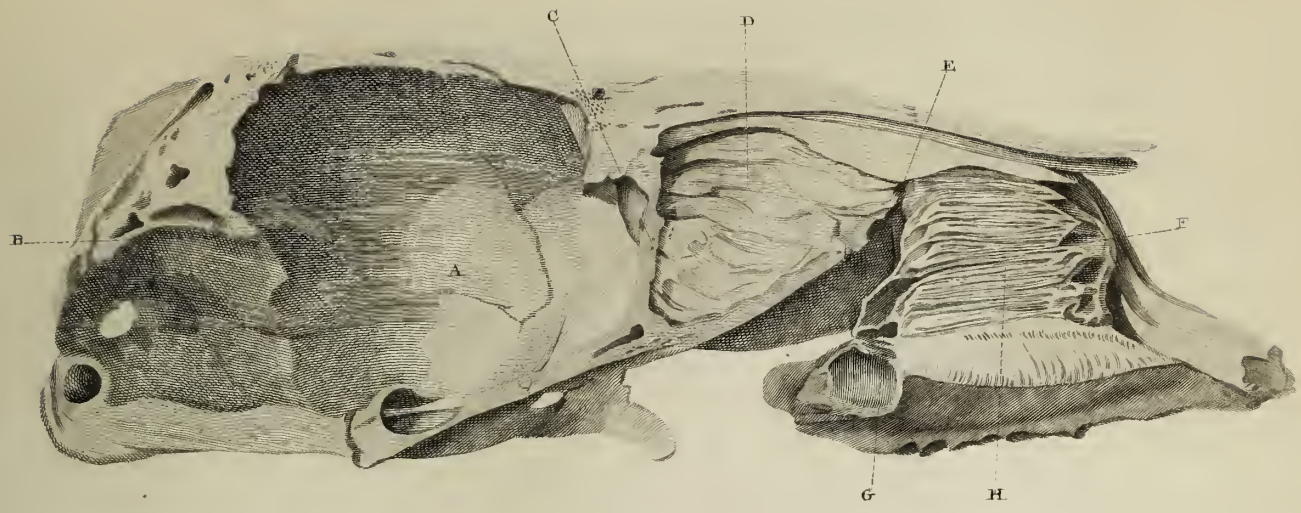
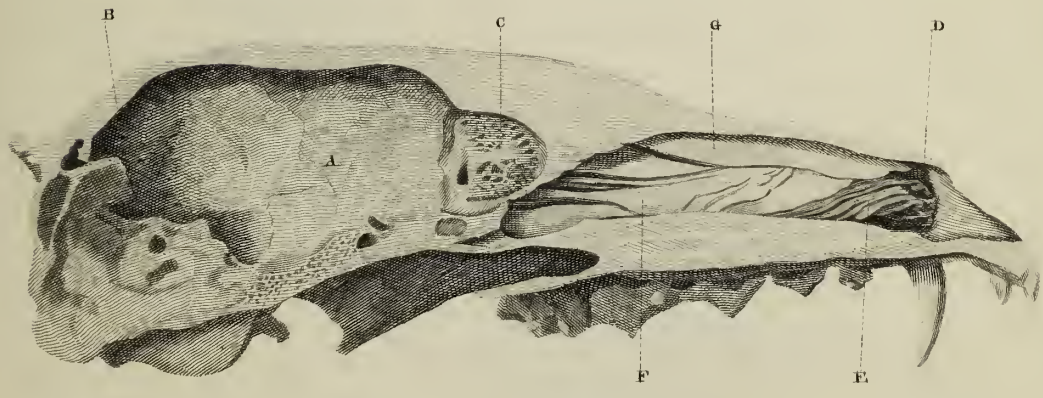


Fig. 2.

Fig. 3.



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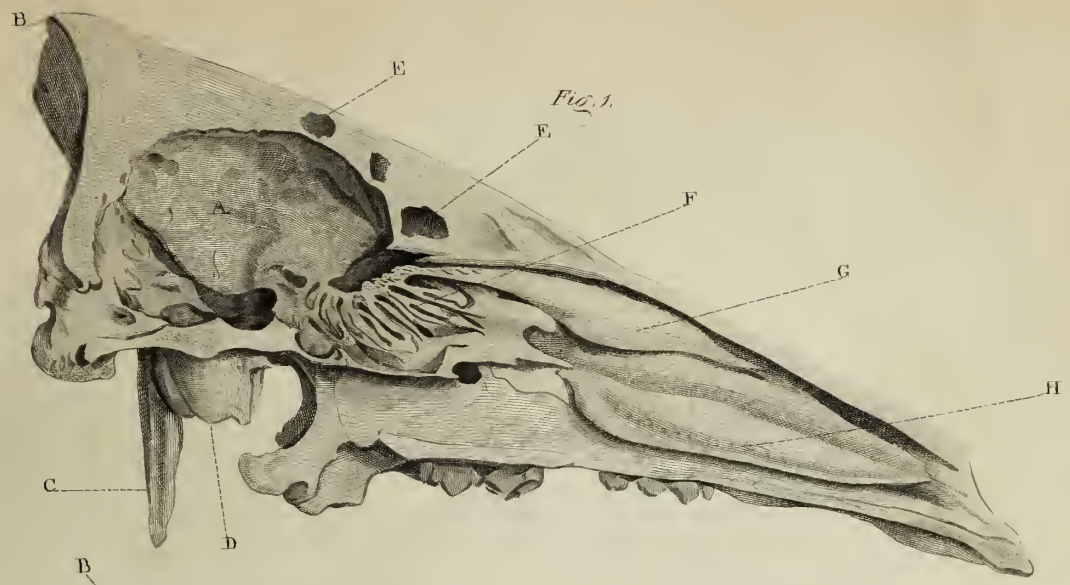

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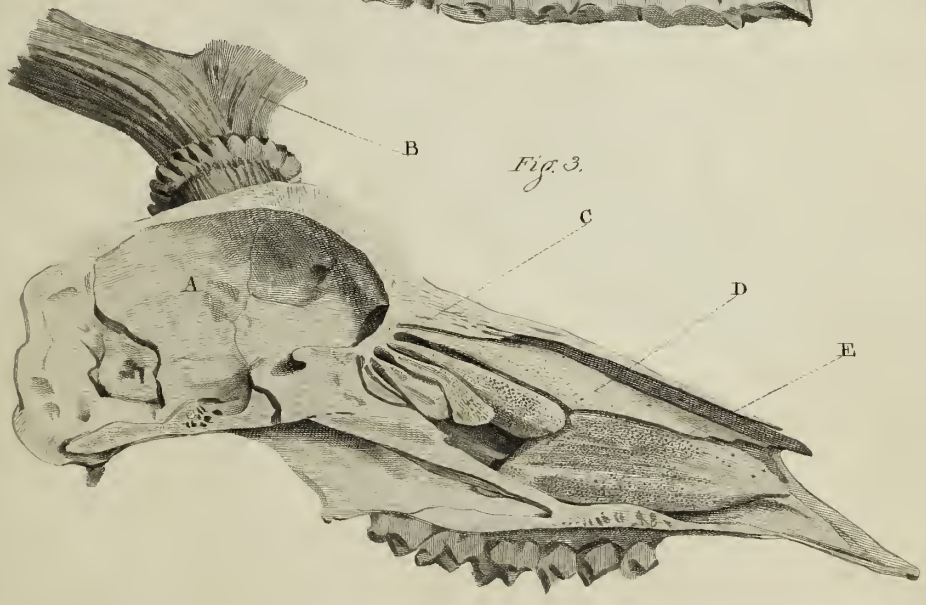

Fig. 3.

T. Phillips del.

J. Heath sculp.

TAB. XV.